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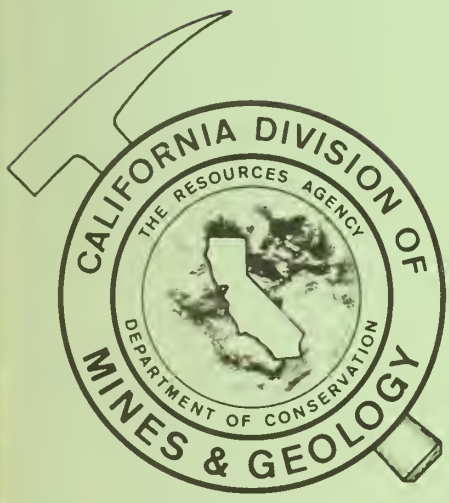

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JAMES F. DAVIS
STATE GEOLOGIST

SEVENTY-FIRST REPORT OF THE STATE GEOLOGIST

ACTIVITIES OF THE CALIFORNIA DIVISION OF MINES AND GEOLOGY

JULY 1, 1977, THROUGH JUNE 30, 1978

James F. Davis, State Geologist
California Division of Mines and Geology
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FOREWORD

California's population and economy continues to grow and people continue to move into the margins of major metropolitan areas. In many urban areas suitable building sites are scarce, and houses are being constructed in geologically hazardous areas - on hillsides or lowlands subject to unstable soil and bedrock conditions, for example, or on sites adjacent to active faults.

The California Division of Mines and Geology has several active local and statewide programs for reducing, mitigating, and predicting seismic and other geologic hazards endangering life and property in California. These programs include the Fault Evaluation and Zoning (Alquist-Priolo) program, the Earthquake Hazard Reduction program, the Strong Motion Instrumentation Program, the Site Evaluation and Review program, and the State Geologic Map project.

The Division has also continued its on-going mission of providing information useful to the mineral industry. In continuing its work on the identification of mineral resources, which was mandated by the Surface Mining and Reclamation Act of 1975, the Division is serving both the mining industry and the public. With the new information local agencies can formulate land-use priorities that encourage the development of crucial mineral resources which are in critical supply before urban development covers the mineral deposits and makes them impractical to mine.

HIGHLIGHTS OF FISCAL YEAR 1977-1978

A major accomplishment of the California Division of Mines and Geology in fiscal year 1977-1978 was the publication of the 1:750,000 scale Geologic Map of California. This 4 1/2 x 5 feet map is designed to show (1) the regional relationships of rock and time-rock units in California, and (2) the tectonic framework. It summarizes geologic mapping in California for use in theoretical and applied planning. This multipurpose map will be useful in preliminary planning of mineral resources investigations, in making regional land use plans, in soil surveys, in locating and planning large-scale civil engineering projects, and in teaching or studying geology and geophysics, as well as such related fields as geography, oceanography, ecology, and soils.

A catalog of information on 40,000 earthquakes that have shaken California between 1900-1974 was released in the form of a magnetic tape and a short text. For each earthquake the catalog has the date, time, epicenter location, focal depth, magnitude, maximum intensity, felt area, and source of information. Records of destructive earthquakes also include the number of lives lost and estimated damage in dollars.

A 1:1,000,000 scale map showing the epicenter locations of all reported earthquakes equal to or greater than magnitude 4.0 or intensity V that occurred within California during the period from 1900 to 1974 was released as Open-File Report 78-4 SAC. There are 2,157 separate epicenter locations plotted on this map representing 3,348 earthquakes.

The review activities of the Division continued at a high level. The evaluation of the seismic potential at the proposed Auburn dam, a U.S. Bureau of Reclamation water storage facility in the Central Valley project, was the largest effort of this kind.

The resumption of a normal rainfall season following the two year drought of 1975 and 1976 predictably resulted in severe landsliding in many parts of California.

James F. Davis was appointed to the position of State Geologist and Chief of the California Division of Mines and Geology effective March 21, 1978. Dr. Davis was the State Geologist and Chief Scientist of the New York State Geological Survey from 1968 until his appointment to the California position. Thomas E. Gay, Jr. who had been acting, limited term or interim State Geologist since October 1975 has resumed his former position as Chief Deputy State Geologist.

Thomas E. Gay, Jr., State Geologist, on August 22, 1977, served as a representative for Governor Brown and delivered a talk at the Ninth Annual Pacific Trade and Development Conference in San Francisco. The talk was titled, "California's Place in Mineral Resources Development Among the Pacific Basin Countries."

DIVISION PROGRAMS

The Division's programs provide technical data to assist public agencies and the private sector in the wise and safe use of the earth's crust, its terrain, and its mineral resources. The overall objective is to identify and provide timely delineation of geologic hazards and to identify, delineate, and assist in the ultimate utilization of deposits of minerals, both onshore and offshore, consistent with wise conservation practices.

Potentially hazardous geologic conditions must be identified prior to land development in order to protect the public from possible economic loss and injury. These hazards include landsliding, ground rupturing caused by fault movements, ground shaking caused by earthquakes, tsunamis (seismic sea waves), volcanic eruptions, land subsidence, expansive soils, and erosion. Deposits of mineral raw materials must be identified and delineated so action can be taken to prevent their loss to urban encroachment.

The following programs deal with environmental concerns and economic mineral resources.

I. Geologic Hazards Program

Division activities directly concerned with geologic hazards are: (1) active fault evaluation and delineation as required by the Alquist-Priolo Special Studies Zones Act; (2) cooperative studies with the U.S. Geological Survey under its Earthquake Hazard Reduction Program; (3) cooperative agreements with local government to identify geologic hazards; (4) installation, maintenance, and operation of strong motion instruments to provide data for earthquake resistant building design; (5) geologic/seismic reviews of reports on hospital, power plant, and dam sites, and environmental impact reports; and (6) geology and forest management.

Photo 1. Slope instability, Puente Hills area, 1978. View southwest. Erosion and supersaturation of slopes beneath bench drains resulted in slouthing and debris flows which seriously damaged house in tract developed during 1970s. This was a widespread problem in this region during the winter of 1977-78. Photo by F.H. Weber, Jr.

1. Active fault evaluation

The Division's active fault mapping program (Alquist-Priolo Special Studies Zones Act of 1972) was established in Chapter 7.5, Public Resources Code. The objective of the law is to provide for the public safety from surface rupture in hazardous fault zones by restricting construction astride active fault breaks. Under the Act, the State Geologist delineates special studies zones about one quarter mile wide along potentially hazardous faults, starting with the State's four major faults: the San Andreas, Calaveras, Hayward, and San Jacinto faults. Under policies generated by the State Mining and Geology Board, local governments permit certain development projects in the special studies zones only after geologic study shows building sites to be free of hazardous faults.

During 1973, the first year of the program, special studies zones along the four major faults were delineated on 175 7 1/2-minute quadrangle maps. After public review, these maps were officially issued on 1 July 1974. During 1974-75, faults in an additional 76 quadrangles were zoned and reviewed, for official release 1 January 1976; also, five of the 1974 maps were revised for reissue. On 1 January 1977, four new and three revised maps were issued, and on 1 January 1978 three new official maps were issued.

During the 1974-75 fault zoning compilation efforts, it became apparent that the Division could no longer rely solely on the work of others in making zoning decisions. There was a clear need for the Division to rely more heavily on its own observations and evaluations in the field and of aerial photographs. As a result, a 10-year fault mapping and evaluation program was planned and approved in early 1976. Under this program, about 3,000 miles of potentially active faults were to be evaluated over a 10-year period on a priority basis (Figure 1). Previously zoned faults were also to be re-evaluated based on new data as it became available. In addition, the phrase "sufficiently active and well-defined" (PRC Sec. 2622) was defined more fully to make it a firm criteria by which effective zoning decisions can be made.

The first area, designated 1977 on Figure 1, was evaluated during the preceding fiscal year. About 30 fault evaluation reports (FERs) were made, and three zone maps were ultimately released in 1978. The 1978 area was evaluated from April 1977 to May 1978, during which time FERs were written for more than 35 faults and recommendations were made to issue Preliminary Maps on July 1, 1978 for four new zone maps and seven revised zone maps.

The Division's fault mapping and zoning activities are summarized in Special Publication 42, Fault Hazard Zones in California (Revised 1977), which is available for $1.00. In addition, Summary Reports on the 1977 and 1978 fault evaluation areas are available as open-file reports OFR 77-8 SF and OFR 78-10 SF; these are available for $4.50 and $3.50, respectively, from the San Francisco District office. The fault evaluation reports (FERs) are in-house reports, but are available for reference at the San Francisco and Los Angeles District offices.

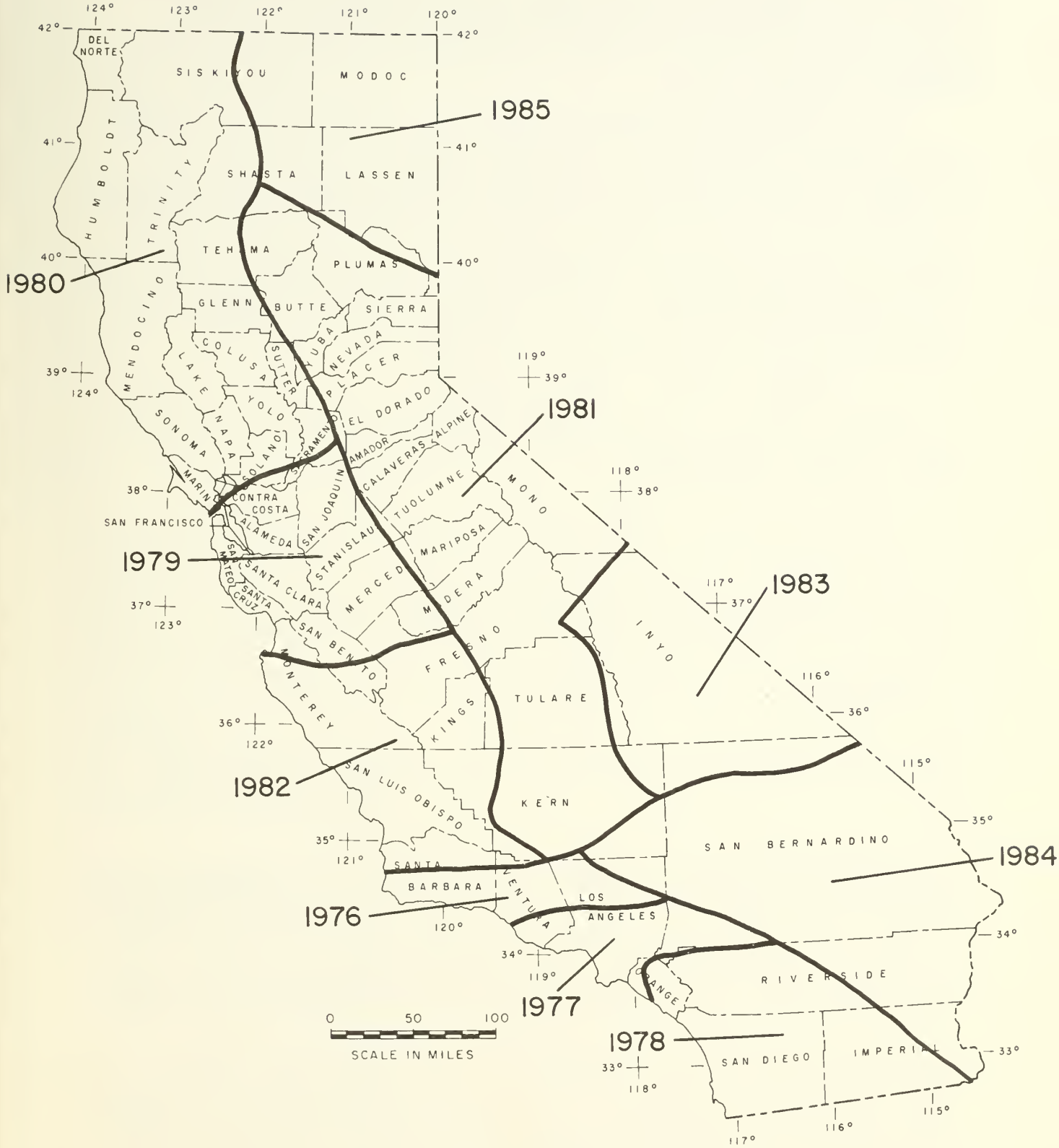

Figure 1. Fault evaluation plan (Alquist-Priolo Special Studies Zones Act) showing work plan priorities.

2. Cooperative studies with the U.S. Geologic Survey

The Division received awards on seven proposals for fiscal year 1977-78 from the U.S. Geological Survey (USGS), Office of Earthquake Studies. These cooperative studies are funded through the USGS Earthquake Hazard Reduction Program, in which the Division has been participating since its inception in 1972.

The seven proposals received a total award of $426,000 from the USGS. These funds were used to carry out studies of (1) the San Andreas fault in northern Los Angeles County, of (2) faulting offshore from metropolitan San Diego, of (3) the Santa Monica-Raymond Hill fault zone through the urban Los Angeles Basin, of (4) the northwestern two-thirds of the San Gabriel fault zone in Los Angeles and Ventura Counties, and of (5) seismic ground response in the urban area of Orange County. The remaining two studies were of State-wide significance and included (6) a compilation of pre-1900 California Earthquake History, and (7) a study to test the feasibility of using preferential coiling directions in foraminifera to establish a base-line age-dating technique for young marine sediments.

These studies have significantly increased our understanding of earthquake hazard in California and contributed to our endeavor to increase public awareness and safety.

Specific Project Status and Staff Participation

Project	Staff	Status
Santa Monica-Raymond Hill fault zone	Hill, Sprotte	1976-1977 Annual Technical Report completed and delivered to USGS in Dec. 1977. Began work on fiscal 1978 contract.
San Andreas fault zone: East Half Quail Lake segment	Kahle	Fault map released as Open-File Report 78-1 LA. Geologic mapping in progress.
San Andreas fault zone: Lake Hughes segment	Beeby	Fault map released as Open-File Report 78-2 LA. Geologic mapping in progress.
San Andreas fault zone: Valyermo segment	Barrows	Fault map released as Open-File Report 78-3 LA. Geologic mapping in progress.
San Andreas fault zone: Three Points segment	Kahle	Field and office work in progress.

Surface faulting in urban San Diego County	Kennedy	Annual Technical Report for 1976-1977 sent to USGS. Work in progress on 1977-1978 contract.
Northwestern 2/3 San Gabriel fault zone, Los Angeles and Ventura Counties	Weber	Annual Technical Report for 1976-1977 submitted to USGS. Work in progress on 1977-78 contract.
Elsinore fault zone, Riverside County, south portion	Kennedy	Published as Special Report 131.
Orange County Basin study	Sprotte, Fuller	Work in progress.
Marine sediments stratigraphic framework	Kilbourne	Work in progress.
Pre-1900 Earthquake Catalog	Toppozada, Real, Bezore, Parke	Work in progress.

3. Cooperative studies with county and local governments

The Division conducts a number of geological studies in cooperation with local government and other State agencies to provide technical information about actual or potential areas of geologic hazard and mineral resources. Some of the studies demonstrate the need for, and the usefulness of, geology to local government planning, building, and public works agencies. Cooperative activities are funded jointly by the Division and the cooperating agency under various arrangements the nature of which depends upon the availability of funds and personnel, the relative urgency of the project to the State and to the cooperating agencies, and other factors.

The status of individual county projects are as follows:

a. Los Angeles County

The Department of the County Engineer and the Los Angeles County Flood Control District continued to provide funds to accelerate the Division's geologic studies in the County. Field mapping is in progress in the southeast quarter Newhall quadrangle. The following reports are in preparation: Juniper Hills quadrangle area; south half Glendora and southwest quarter Mt. Baldy quadrangles; southwest quarter Calabasas and southeast quarter Thousand Oaks quadrangles; south half Mint Canyon quadrangle; parts of Oat Mountain quadrangle; and northeast quarter Newhall quadrangle.

The Los Angeles Department of the County Engineer also continued to provide funds to accelerate the Division's cooperative fault hazards study with the USGS Earthquake Hazard Reduction Program in the San Andreas fault zone in the northern portion of the County. Fault maps of the Quail Lake, Lake Hughes, and Valyermo segments of the San Andreas fault were completed. Geologic mapping of the Quail Lake, Lake Hughes, and Valyermo segments of

the San Andreas fault is in progress. The following reports are in preparation: Leona Valley segment of the San Andreas fault (OFR 77-2 LA) by James E. Kahle, Drew P. Smith and David J. Beeby; Palmdale segment of the San Andreas fault (OFR 76-6 LA) by Allan G. Barrows, James E. Kahle, and David J. Beeby. Three open-file reports were released:

(1) OFR 78-1 LA: Preliminary Fault Map, East Half Quail Lake Segment, San Andreas Fault Zone, Los Angeles County, California, by James E. Kahle, 1977, 21 p., 1 plate, scale 1:12,000.

(2) OFR 78-2 LA: Preliminary Fault Map of the Lake Hughes Segment, San Andreas Fault Zone, Los Angeles County, California, by David J. Beeby, 1977, 22 p., 1 plate, scale 1:12,000.

(3) OFR 78-3 LA: Preliminary Fault Map of the Valyermo Segment, San Andreas Fault Zone, Los Angeles County, California, by Allan G. Barrows, 1978, 25 p., 1 plate, scale 1:12,000.

b. Orange County

The Orange County Environmental Management Agency (Department of Building and Safety, Road Department, and Orange County Flood Control District) continued to provide funds to accelerate the Division's geologic studies in the County. Field mapping is in progress in the southwest quarter and part of the northwest quarter of the Santiago Peak quadrangle and in the west part of Black Star quadrangle. The following reports are in preparation: La Habra, Yorba Linda, and Prado Dam quadrangles; north half El Toro quadrangle; recency of faulting in Orange County. A report on the environmental geology of Orange County is being processed for publication.

c. Marin County

The final report and maps portraying geologic land use constraints for the Inverness, Tomales Bay, Olema, and Bolinas areas in western Marin County were completed and delivered to the County. The completion of this project marks the end of 7 years of cooperative effort between the Division and the County in which the Division has provided geological information relevant to land use planning for all the major developing areas within the County.

d. Sonoma County

The final report and maps for the slope stability study of the Mark West Springs-Porter Creek area were delivered to the County. The Division entered into a new cooperative agreement with the County to provide a slope stability and surface fault rupture analysis of the Chalk Hill Road area. This work is in progress.

e. Santa Clara County

The Division completed a geologic hazards study of a 14 square mile area along the eastern foothills of the Santa Clara Valley east of Morgan Hill. The final report and maps were presented to the County at the end of

the year. The Division signed a new cooperative agreement with Santa Clara County to provide a report and geologic and interpretive maps for the Sargent Ranch area in the extreme southwestern part of the County.

Specific Project Status and Staff Participation

Project	Staff	Status
Juniper Hills quadrangle	Barrows	First draft completed 1974-75; recessed during 1975-76 for other San Andreas area. Revised report nearly complete as of June 1978.
Pasadena quadrangle	Smith	Mapping completed; first draft nearly completed.
South half Mint Canyon quadrangle	Saul	Revising report of SW/4 and combining with SE/4 to make one report on S/2.
South half Glendora and southwest quarter Mt. Baldy quadrangles	Streitz	Report being revised after Headquarters review; maps being scribed.
Calabasas and Thousand Oaks quadrangles	Weber	Report being prepared for open-file Release (OFR 77-7 LA).
Southeast quarter Oat Mt. quadrangle	Saul	In publication processing. Map being scribed. To be printed as Map Sheet 30.
Southwest quarter Oat Mt. quadrangle	Evans	In publication processing. To be printed as Map Sheet 33.
Geoenvironmental report on Orange County	Morton, Miller	Revised report text complete. Plates being drafted.
La Habra, Yorba Linda, and Prado Dam quadrangles	Tan, Miller	Revised first draft completed after District review.
Orange County; recency of faulting study	Miller, Tan	Report revised after District review of first draft. Text and maps being revised in accord with second draft review.

Ventura County seismic hazards study	Weber, Sprotte, Kiessling, Cleveland, Johnson*, Sherburne	In publication processing. Open-file release (OFR 76-5 LA).
N/E quarter Newhall quadrangle	Smith	Report being revised after District review of first draft.
S/E quarter Newhall quadrangle	Treiman	Mapping initiated.
North half El Toro quadrangle	Tan, Fife, Miller	Mapping completed; first draft completed.
SW/4 and part of the NW/4 Santiago Peak quadrangle	Miller, Morton	Mapping completed for both parts; first draft nearly completed.
West part Black Star Canyon quadrangle	Tan, Miller	Field mapping in progress.
Haiwee Reservoir quadrangle	Stinson	Published as Map Sheet 37.
Keeler quadrangle	Stinson	Published as Map Sheet 38.
Sonoma County; Mark West Springs	Armstrong	Field work completed, final report and maps delivered to County.
Sonoma County; Chalk Hill Road area	Armstrong	Field work in progress.
Sonoma County; County-wide study to assist in preparation of general plan elements.	Huffman, Armstrong	To be published as Special Report 120.
Marin County; Olema, Inverness, Tomales Bay, Pt. Reyes Station and Bolinas areas	Wagner	Field investigations completed; maps and report delivered to County.
Santa Clara County; Mt. Diablo foothills	Armstrong, Wagner	Study completed; report and maps delivered to County.
Santa Clara County; Sargent Ranch area	Armstrong	Agreement approved. Work to start in next fiscal year.

*Geologist no longer with the Division.

4. Srong-motion instrumentation

One of the primary problems confronting structural engineers in their efforts to design earthquake resistant structures is the lack of knowledge regarding the force of ground motion and the deformation induced in structures and facilities by earthquake generated ground motion. In late 1971, Chapter 8 of Division 2 of the Public Resources Code (SB 1374) was signed into law to establish a Strong Motion Instrumentation Program (SMIP). The California Division of Mines and Geology was designated as the responsible managing agency.

The Division is installing, maintaining, and monitoring a network of strong-motion instruments to study the nature of strong earthquake motion and collect data for the design of earthquake resistant buildings. This activity is supported by a special fund derived from a fee on all construction permits issued by cities and counties.

The SMIP objective is to obtain statewide detailed records of the response of rock and soil units and of engineered structures to ground motion generated by earthquakes. The accelerometer, an instrument that measures the force-generating properties of seismic waves, is used to record these data.

During fiscal year 1977-78 the Strong Motion Instrumentation activity, operated by the Office of Strong Motion Studies from Sacramento and San Bernardino, completed seven years of operation.

(a) (b) (c)

Photo 2. Installation of strong-motion instruments. (a) Down-hole array site, showing the two drill holes 0.6 meters (2 feet) apart on the concrete foundation. After instrumentation is completed a housing will be placed over the foundation. (b) The accelerometer cannister attached to the loading pole assembly is lowered into the bore hole. (c) The bottom-hole instrumentation is emplaced and oriented. After the assemblage is cemented in place the loading pole is removed, the pipe is trimmed to casing level and the hole is backfilled. Photos by T.M. Wootton.

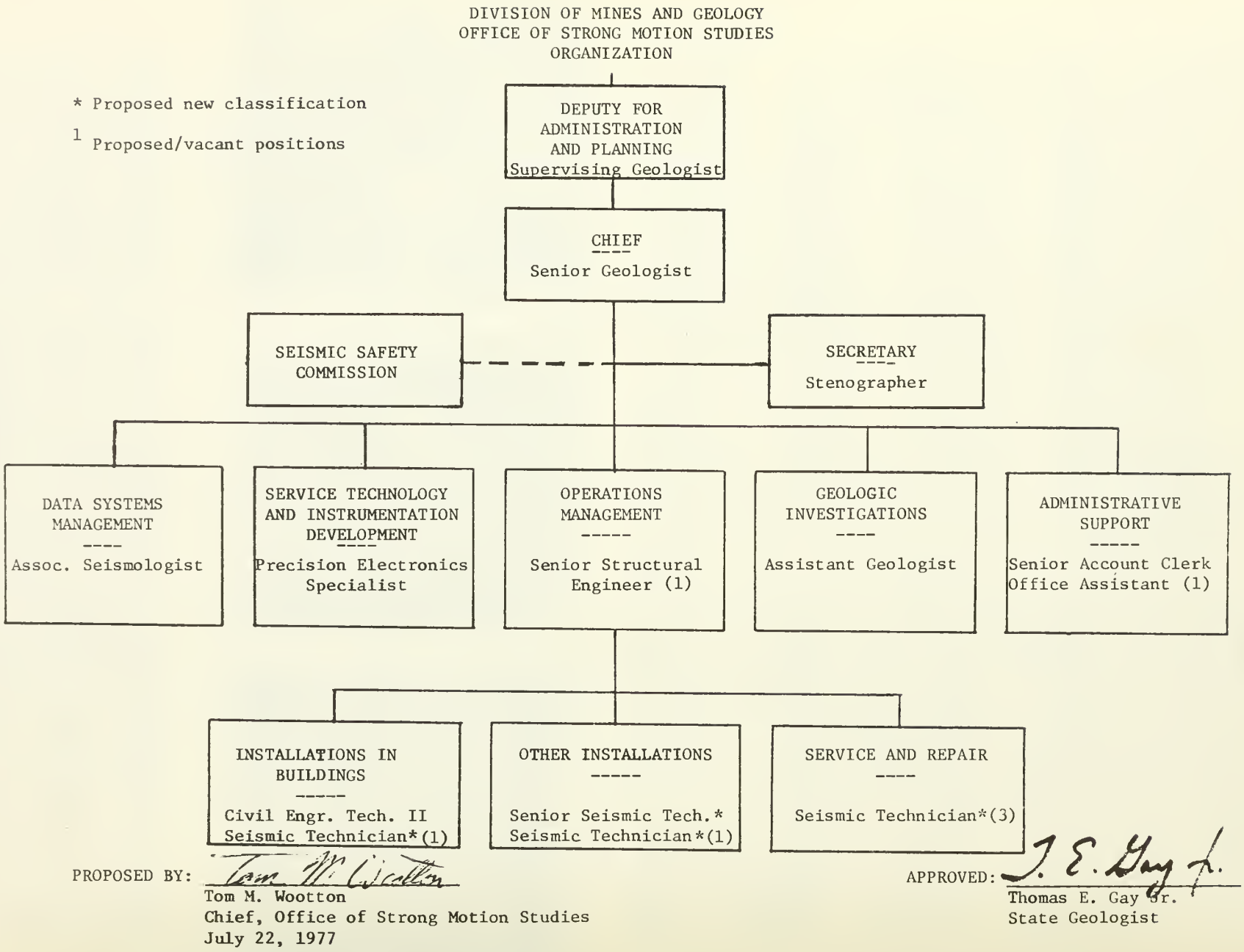

Figure 2. Office of Strong Motion Studies organizational chart.

A cooperative agreement with the U.S. Department of Transportation was proposed in February 1978 to instrument the Caldecott Tunnel. This proposal is to monitor the tunnel with a nineteen channel digital recording system, with thirteen data channels recording tunnel response and six data channels recording freefield response (three data channels are to be placed in the subsurface at tunnel grade). Proposed completion of the project is in the 1979-80 fiscal year with 75 percent of the estimated costs paid by the federal government and 25 percent by the State. Additionally, a project to instrument the Vincent Thomas Bridge has been proposed as a three-way cooperative effort by the U.S. Department of Transportation, the U.S. Geological Survey, and California Division of Mines and Geology. Active planning for this project is anticipated in fiscal year 1978-79.

The buildings, transportation facilities, and lifeline elements to be used as ground response sites in the program were selected with the advice and assistance of the Strong Motion Instrumentation Committee of the Seismic Safety Commission. The Committee encouraged a variety of organizations and agencies to nominate sites and structures for instrumentation. In this way the Committee put together a list of nominations for instrumentation that included 54 buildings, 49 transportation facilities, 30 dams and 17 lifeline facilities such as power plants, water treatment plants and water transmission/storage structures.

Eighteen freefield installations, instrumentation of six buildings, and the instrumentation of three dams with fifty-one data channels were added this year. Of the three dams, two were completely reinstrumented with latest state-of-the-art systems. At the end of the 1977-78 fiscal year, a total of 255 freefield installations (including 2 down-hole sites), 35 buildings, 16 dams, and 3 bridges had been instrumented, making a grand total for the program to date of 309 active installations.

During the year problems associated with a number of freefield sites were corrected. A review of building system performance disclosed a manufacturing deficiency in central recording accelerographs. Correcting the problem took priority over the instrumentation of new sites, and the program's rate of expansion has suffered. Sometime early in the fiscal year 1978-79 the program is expected to resume its normal rate of progress.

A Data Management function is an important addition to the SMIP activity; it will ultimately be able to process and disseminate strong-motion data to user communities. Initial steps to develop this data processing capability were taken immediately after the authority and mandate to do so were provided by the adoption of Chapter 1243, Statutes of 1976, on January 1, 1977. Work has been started on a departmental Feasibility Study Report (FSR), which is required by the State Department of Finance before any significant funds can be spent for data processing activities.

As expected, during fiscal year 1977-78 the operations and staffing of the program increased in complexity and size, justifying the previous year's consolidation into an independent unit of the Division organized along functional lines (Figure 2). Since the consolidation there have been only minor changes in job titles and reporting relationships. Effects of the passage of Proposition 13 were not felt in the fiscal year ending on June 30,

1978. The activity was budgeted at $679,233 for the year. Actual expenses totaled $667,450 with revenues of $914,132, resulting in a net gain to the Strong Motion Instrumentation fund of $246,682.

5. Geologic/Seismic reviews

a. Hospital sites

The Division continued to review reports under the provisions of the Hospital Safety Act (Health and Safety Code) which became effective March 7, 1973. This Act required that new hospitals, including additions, reconstructions, and out-patient facilities, be functional during and after an earthquake or other natural disaster. During fiscal year 1977-78 the Division provided the review of 88 new and supplemental geologic/seismic hospital-site reports that were submitted to the State Office of Architecture and Construction by consulting engineering geology firms.

b. Nuclear and fossil fuel power plant sites

The Energy Resources Conservation and Development Commission (ERCDC) and the California Division of Mines and Geology continued their contract agreement. The Division provided geologic and seismologic advice on geologic hazards and risk pertinent to potential fossil fuel and nuclear electrical generating sites. Efforts were directed to the preparation for and review of Notice of Intention (NOI) documents prepared by the utilities on a statewide basis. Documents studied and evaluated were from diverse areas and concerned varied geologic hazards. The Geysers area geothermal sites were reviewed and evaluated for hazards from landslides, active faults, and earthquakes of tectonic and geothermal origin. San Francisco Bay area fossil fuel plant sites were reviewed and evaluated for hazards from poor foundation materials, active faults, and possible great earthquakes. Reviews of desert area nuclear power plant sites required extensive study because of the nature of the facility and the lack of in-depth data on the geologic hazards.

Cooperation between the Nuclear Regulatory Commission (NRC) and the Division continued and has expanded from nuclear power plants to other nuclear installations such as radio-medical facilities.

c. Oroville and Auburn dam sites

As a result of public concern over the seismic safety of the proposed U.S. Bureau of Reclamation Auburn dam, the site of which is located in the same Foothill shear zone that generated the Oroville earthquake, the Division was asked to represent the Department of Conservation in a joint effort with the Department of Water Resources (CDWR) to perform an Auburn Dam Seismic Safety Review for the State of California. Following the June 27-30, 1977, meeting of the State's Consulting Board for Earthquake Analysis for Auburn Dam, the Division became actively involved in gathering information pertinent to the seismic safety of Auburn dam. Early in the period the Division created a "task force" to do this work. The members of the task force -- four geologists, a soil scientist, and a seismologist -- had the support of laboratory and other staff members to process samples, check

background materials, and do compilations. To assure coverage without overlap, the work was broken down into "mini-projects" that could be assigned to members of the task force. These projects included: (1) East Maidu fault studies; (2) Fault studies outside the dam site; (3) Dam site foundation excavation detail; (4) Foothill lineament studies; (5) Seismicity studies; (6) Induced seismicity studies; (7) Geomorphic studies; and (8) Oroville earthquake event analysis.

At its June 1977 meeting the CDWR Consulting Board for Earthquake Analysis of Auburn Dam requested a resurvey of existing first order level lines across the Melones and Bear Mountain faults. Arrangements were made to have CDWR level crews do the work; one-half of the cost of this was to be paid by USBR, one-third by CDWR, and one-sixth by the Division. The results of the resurvey were received by the Division on January 27, 1978. They indicate a maximum vertical displacement on the Loomis to Applegate line of 2 cm within one mile of the dam site since the 1969 survey.

The Division's Auburn dam task force spent a great deal of time and effort reviewing the USBR Project Geology report on seismic evaluation of Auburn dam site, which it received September 21, 1977. In January 1978, when the final volume of the Woodward-Clyde Consultants report was received, the task force subjected it to the same kind of intensive, in-depth review. Individual members of the task force produced commentaries reflecting their respective fields of expertise. These commentaries were the subject of a series of in-house meetings held in May 1978 to help determine the Division's position concerning the Woodward-Clyde Consultants report and conclusions. In general, the Division's task force members expressed agreement with the major body of the Woodward-Clyde Consultants report and with the methods of study used to develop the information presented therein.

The Division also expects to review and comment on all other pertinent geologic or seismologic reports relative to the seismic safety of the site. Still to come are several reports from USBR. The information obtained in the review process plus that developed by the Division's task force members in their field studies in the Auburn to Oroville areas will serve as background in developing the Division's position paper on the seismic safety of the Auburn dam site. The position paper is to be completed in fiscal year 1978-79 and is expected to be transmitted to the USBR as part of the State's official position on the seismic safety of the site.

Project Assignments and Staff Participation

Studies	Staff
Regional and local geology	Aune, Bacon, Rice, Taylor
Soils	Borchardt
Seismicity, induced seismicity	Cramer, Toppozada
Leveling surveys	Bennett

d. Environmental impact reports

The Division has continued to review environmental impact reports (EIRs); approximately 286 reports were processed by the staff in 1977-78. The EIRs reviewed covered a variety of projects, including sites for power plant facilities, petro-chemical facilities, subdivisions, school sites, dam sites, and mining activities. All projects are reviewed using the Division's EIR guideline (CDMG Note 46). Problems that could develop from earthquake, fault rupture, landslide, erosion, expansive soil, tsunami, subsidence, and volcanic eruption, as well as the requirements of mineral resource conservation and mined-land reclamation, are considered in the review.

The most significant projects, which involved the review of many supplemental reports and attendance by the staff at numerous meetings, were the Warm Springs dam, the SOHIO project, liquefied natural gas facilities, coastal zone developments, and geothermal power plant sites.

e. Geology and forest management

Three staff members have been assigned full-time to the Department of Forestry for geologic studies under contract arrangement. The work involved reviewing timber harvesting plans and soil erosion studies to determine the effect of Forest Practice rules under the directive of a Section 208 water quality policy study.

Photo 3. Low-angle aerial view westerly from Redwood Creek towards Rodgers Peak (Humboldt County) in the north coastal area of California. The upper portion of the hillside was harvested in the 1960s by the clear-cut method. The rectangular areas in the foreground were harvested in 1974 and 1975 under the Z'berg-Nejedley Forest Practice Act of 1973, which required timber harvesting plans which set limits on the size of clear cuts. The role of the geologist is to identify geologic factors conducive to erosion, provide a professional opinion concerning the probable impacts of the proposed logging on these factors, and recommend (along with other specialists) mitigation measures. Photo by Dale L. Wierman, California Department of Forestry.

Project	Staff	Status
Department of Forestry, Timber Harvesting Plan Review	Huffman, Ristau	Two full-time assignments.
Board of Forestry (water-quality and erosion)	Hauge	One full-time assignment. Interim report on soil erosion study.

II. Seismological/Geophysical Program

Under the Seismological/Geophysical Program the Division (1) studies, (2) catalogs, (3) and monitors earthquakes; it also (4) investigates crustal movement, (5) studies possible methods of earthquake prediction, and (6) conducts geophysical surveys.

1. Microearthquake studies

The Division added four portable digital event recorder systems (3-component) to its eight portable smoked-drum recording systems. The new digital event recorders were received in May, and field tests began in June. These instruments are being deployed for use in various studies pertinent to the assessment of seismic risk, including (1) the identification of faults that are seismically active, (2) refinement of zones of active faulting that are being mapped under the mandate of the Alquist-Priolo Act, (3) the study of damaging earthquake aftershocks to determine the seismic/geologic relationships of the earthquake process, and (4) the investigation of possible reservoir related earthquake activity to better understand the potential for reservoir induced seismicity in California.

From September to December, 1977, the smoked-drum recorders were operated in an eight station array along the Cucamonga and Sierra Madre faults in Los Angeles County. The array, located between San Antonio and San Gabriel Canyons in the San Gabriel Mountains, was maintained by earth science students at California Polytechnic University, Pomona. Few microearthquakes were recorded within the array during this period; analysis of the records is in progress.

In response to the opportunity presented by the drought of 1975-77, portable smoked-drum recorders were installed at two reservoirs to monitor earthquake activity possibly related to the large draw-down and then refill of those reservoirs. In January, 1978, two instruments were placed near the New Bullards Bar reservoir in the Sierra Nevada foothills east of Oroville. Some microearthquake activity has been observed along a segment of the Foothills fault system. During June 1978, the smoked-drum recorders were replaced by two digital event recorders. Division seismologists, geologic aids, and student assistants have maintained these stations out of the Sacramento District office.

From March 1978 to July 1978, a three station array of portable smoked-drum recorders, supplemented by the CDWR station at Whiskeytown reservoir, monitored earthquake activity near Shasta and Trinity reservoirs in northern California. These stations were maintained by geoscience students from

Shasta College in Redding. Some earthquake activity was observed in the Shasta-Trinity area but at depths generally greater than 15 km. Both the Shasta-Trinity and New Bullards Bar records are being analyzed, but no obvious, large increase in earthquake activity seems to be associated with these reservoirs following refilling after the drought.

On March 26, 1978, a magnitude 4.5 earthquake occurred near Ukiah. Three smoked-drum recorders, supplemented by the U.S. Geological Survey stations south of the activity, monitored the aftershock sequence from March 1978 to July 1978. These stations were maintained by a student from the Mendocino Community College in Ukiah and Division geologic aids and seismologists from Sacramento District. The earthquake activity was centered on a portion of the Maacama fault beneath Lake Mendocino.

2. Earthquake catalog

The earthquake catalog was used by Division seismologists to review the historical seismicity in areas surrounding critical structures such as dams and power plants, for the purpose of assessing the seismic hazard at these sites.

A catalog of information on 40,000 California earthquakes, that occurred from 1900 through 1974, has been released in the form of a magnetic tape. For the period 1900 through 1931, before adequate statewide seismographic coverage was established, earthquakes of magnitude about 4 and greater only are included. A separate report describing these larger earthquakes that occurred from 1900 through 1931 has been completed and was in press in June 1978. A wall map of California showing the epicentral distribution and magnitude ranges of the larger (magnitude 4 and greater) earthquakes that occurred from 1900 through 1974, was released in open-file form(Figure 3).

Work started on a project funded by a grant from the U.S. Geological Survey to research California's earthquake history for the period before 1900. A proposal was submitted to the U.S. Geological Survey to fund a second year of research into California's pre-1900 earthquake history. The proposal was accepted and will be funded for one year starting in 1979.

3. Earthquake monitoring

The Division improved its awareness of California's seismicity by adding two additional seismographic recorders; one of these recorders is located in the lobby of the Resources Building. Three different seismic signals are telemetered to these recorders; the signals originate in north, central, and southern California, and aid in maintaining the Division's immediate awareness of California's gross (M 4) earthquake activity. This prompt awareness helps the Division in its activities related to earthquake prediction, post-earthquake aftershock studies (Ukiah, March 1978), clearing house (post-earthquake coordination) functions, and the deployment of strong motion instruments (Maacama fault zone).

Under a continuing agreement with the Seismological Laboratory of the California Institute of Technology, the Division provides funds for the recording and study of earthquakes in southern California. The California

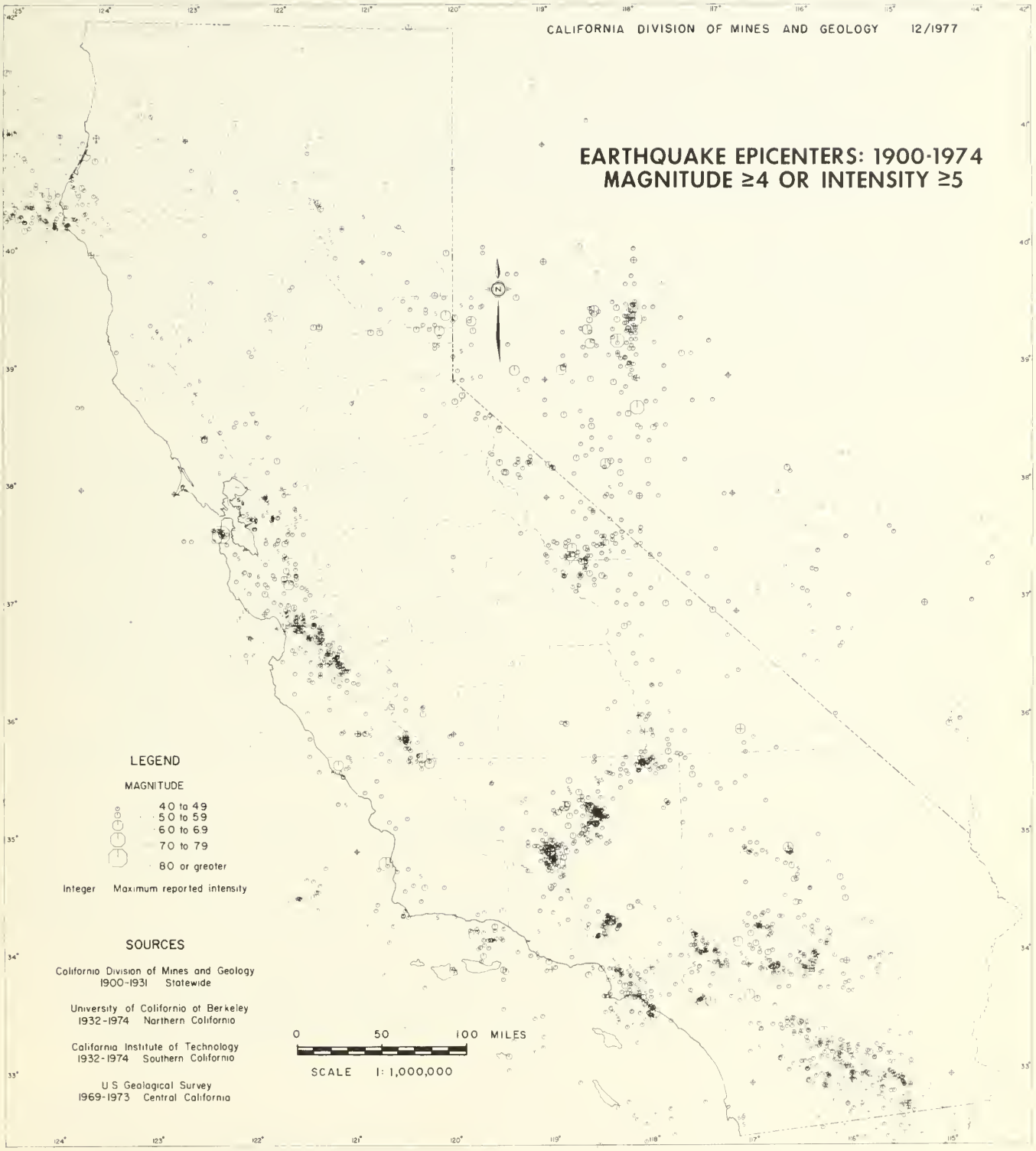

Figure 3. Epicenter map for California (1900-1974)

Institute of Technology supplies prompt notification by telephone of the location of all M 4 earthquakes in southern California and monthly listings of preliminary epicenter determinations for all locatable earthquakes in southern California. Similar information is provided by the Seismographic Station of the University of California at Berkeley.

4. Crustal movement investigations

The Division's crustal movement investigations have the ultimate objectives of identifying active faults and understanding the geologic processes by which large earthquakes are generated. These objectives are advanced through such geodetic data collection and analysis activities as (1) the continuous monitoring of long-term strain rates at selected locations along the San Andreas fault system to detect anomalous changes, (2) the intensive surveillance of seismically active areas to improve our understanding of relationships between fault mechanics and the occurrence of earthquakes, (3) the study of characteristics of movement occurring on faults of unknown activity, and (4) the recognition and location of otherwise indiscernable near-surface faulting within alluvial basins.

To assess long term horizontal deformation (strain) occurring along the San Andreas fault system, remeasurements of selected lines (10-30 km in length) in the State Geodimeter network were completed. These laser distance measurements included (1) the first remeasurement of an extensive trilateration network (established by the Division in 1974) extending from the San Andreas fault near Cholame in San Luis Obispo County westward to the Pacific Ocean near Morro Bay and (2) continued semi-annual remeasurements along a 50 km segment of the San Andreas fault between Parkfield and the Carrizo Plain. These semi-annual measurements are specifically directed toward understanding fault mechanics in this region of relatively frequent, moderate (M5-6) earthquakes. The measurement history developed by the Division along this fault segment in recent years represents the most intensive geodetic surveillance data developed anywhere along the San Andreas fault system.

Several small (1-2 km aperature) survey networks were remeasured to determine fault movement activity. These surveys included:

(1) Cholame Valley (San Andreas fault): A creep rate of 6 mm per year has been confirmed by Division surveys since 1974.

(2) Etiwanda (Cucamonga fault): The first horizontal remeasurements of a network established during early 1977 were made; results are in close agreement with the original survey. First-order leveling to monitor vertical movement was completed under contract with San Bernardino County Surveyor.

(3) Geyserville (Healdsburg-Alexander Valley fault): A network was established to monitor suspected fault creep, and initial measurements were made.

(4) Palmdale "uplift" region: Existing National Geodetic Survey networks on the San Andreas fault were remeasured for evidence of horizontal fault movement. The results revealed no evidence of movement during the past decade.

Equipment and procedures, along with the results of some of these surveys, were described in an article prepared for subsequent publication in CALIFORNIA GEOLOGY (May 1979).

During the winter of 1976-77, the Division initiated and cooperated with the County of Los Angeles and the California Department of Water Resources in the execution of some 550 km of first-order releveling to appraise the status of the Palmdale uplift. This project detected a 50 percent collapse of the previous uplift in the Palmdale-Antelope Valley region. These results were described in an article published in CALIFORNIA GEOLOGY (August 1977).

As a result of an earlier Division analysis of crustal movement in the northern Sierra Nevada (March 1977, CALIFORNIA GEOLOGY), the Department of Water Resources Consulting Board for Earthquake Analysis for Auburn Dam recommended additional leveling surveys across the Bear Mountain fault zone to facilitate their assessment of design parameters for the proposed Auburn dam. Consequently, between December 1977 and January 1978, 62 km of first-order releveling was completed in the Auburn area under a cooperative cost-sharing agreement between the U.S. Bureau of Reclamation, the California Department of Water Resources, and the Division. The results confirmed the geologic evidence for identification and location of the Bear Mountain fault zone and demonstrated that deformation attributable to regional tectonics was occurring across that zone. The fact that the proposed Auburn dam site lies within this zone of deformation was an acknowledged influential factor in the Board's subsequent conservative judgments concerning earthquake motions that the dam should withstand. An analysis of these surveys and an accompanying article describing the Auburn dam site were prepared for publication in CALIFORNIA GEOLOGY (August 1978).

Analysis of high-order leveling surveys conducted by the City of Los Angeles in the Beverly Hills-Hollywood area was completed. These studies were undertaken as part of a comprehensive geologic investigation of the Santa Monica-Hollywood-Raymond Hill fault, funded by the U.S. Geological Survey as part of the Earthquake Hazards Mitigation Program. When interpreted with corroborative ground water and oil well data, it was concluded that the near surface trace of the Santa Monica fault traverses the Beverly Hills-Hollywood area and is defined by a narrow zone of differential subsidence that is evidenced by the leveling surveys. Results of these studies were presented at the International Symposium on Recent Crustal Movements at Stanford University (July 1977) and prepared for subsequent publication in the Bulletin of the Association of Engineering Geologists.

5. Earthquake prediction studies

The Division is using four techniques for studying earthquake precursory effects.

a. Tiltmeter program

The Division's tiltmeter program, which measures tilting of the earth in relation to earthquake activity, was temporarily discontinued in the Parkfield-Cholame Valley region of the San Andreas fault but was continued at

Oroville. Instruments in the Parkfield-Cholame Valley area were removed for modification, repair and recalibration; they were rebuilt and made ready for installation by Kinemetrics Inc. of Pasadena, California. Aftershocks of the M 5.7 Oroville earthquake of August 1, 1975, continued to occur, but they were of magnitudes less than 4 and were located more than 10 km from the instrument. Preliminary interpretation of the tilt record shows no obvious precursor to any of these aftershocks. The 13°F seasonal variation of temperature in the vault accounts for the major variations in tilting that were observed. However, further reduction of the data and elimination of temperature effects may reveal a small increment of tilt related to earth surface deformation.

b. Gravity technique

The gravity technique consists of monitoring a series of gravity stations along the San Andreas fault near Cholame. These stations are monitored every three to six months to detect elevation changes that may precede an earthquake.

c. Telluric currents technique

The telluric current-self potential method compares telluric current variations to indirectly measure rock resistivity changes that may precede earthquakes. The Division is currently operating three telluric current arrays along the San Andreas fault. Results to date have indicated an apparent precursory effect prior to a moderate earthquake in January 1975 in the Parkfield area, and also possible precursory effects to a small swarm of earthquakes that occurred in April-May 1976 and a single small event that occurred in November 1977 in the area north of Parkfield. Preliminary interpretation of subsequent measurements have so tar not shown anomalous readings, and no significant earthquakes have occurred in the array areas.

d. Microacoustic emissions technique

Microacoustic survey stations (to detect high frequency emissions that may occur prior to an earthquake) are maintained at five sites between Palmdale and Parkfield along the San Andreas fault, and are monitored by the Division on a monthly schedule. Because the sites extend from the center of the Palmdale "bulge" along the flank to the northwest, the Division has been especially concerned with data interpretation. The results show a general quieting trend of background acoustic emissions beginning in early 1976 and continuing, with minor fluctuations, to the present. The reasons for this trend are not yet thoroughly understood.

6. Geophysical surveys

The Division conducted a number of geophysical surveys during fiscal year 1977-78. Some of these were in support of geologic projects to help define subsurface structures and others were done as primarily geophysical studies. The principal uses of the geophysical data were to define fault zones, locate mineral deposits, and define favorable areas for geothermal resources.

Activity continued on the Gravity Maps of California project. The Needles Gravity Sheet map was printed, and its release is expected shortly after the end of the 1977-78 fiscal year. The Death Valley Gravity Sheet map was printed on the new geologic base map and its release is also expected soon. Work is in progress on the Fresno, revised Santa Cruz, Santa Maria, Long Beach, and Mariposa gravity maps. All of these gravity maps are at a scale of 1:250,000. The principal facts and sources for the gravity stations on the Alturas and Needles 1°x 2° sheets were released as Open-File Reports 77-17 SAC and 77-18 SAC respectively. The state gravity map at a scale of 1:750,000 was completed in draft form, and the accompanying text is near completion.

Geophysical field and office support for several cooperative investigations was provided in the form of magnetic surveys, gravity surveys, seismic refraction surveys, and electrical resistivity surveys. These surveys provided information pertinent to the determination of local bedrock and water table depths, the identification of buried faults, and the measurements of variations in the thickness of subsurface strata and the seismic velocity of local rock units. Cooperative geophysical investigations were undertaken for the studies tabulated in the "geophysical" listing.

The results of the cooperative aeromagnetic survey flown during the summer of 1976 off the coast of central California by the Division and the U.S. Geological Survey were published as U.S. Geological Survey Open-File Report 77-79. The survey area included several major offshore fault zones (Hosgri, Palo Colorado-San Gregorio, and Sur-Nacimiento).

The geophysical investigation of the Canby-Kelly Hot Springs area was completed and the results released as Open-File Report 78-5 SAC. This is an area with potential for development of geothermal resources.

Specific Project Status and Staff Participation

Project	Staff	Status
Active fault identification	Cramer, Bennett, Chase, Chapman, Campbell	Seismic calibration shots were made in support of the Cucamonga fault study. Seismic monitoring continued at Shasta-Trinity, Bullards Bar, and Ukiah.
Earthquake catalog, 1900-1931	Toppozada, Higgins, Parke	Special Report 135 prepared for publication.
Earthquake catalog, 1932 onward	Real	Epicenter Map published as Open-File Report 78-4 SAC.
USGS coop earthquake catalog, pre-1900	Toppozada, Real, Parke, Bezore	Work in progress.

Tiltmeter program	Bacon, Durrwachter, Sherburne, Toppozada	1 tiltmeter operating in Oroville; results being analyzed.
San Diego (Otay Valley)	Kennedy and others; Chase, Campbell	Geophysical work completed and report prepared.
Santa Monica-Raymond Hill fault zone (USGS Coop)	Hill, Real, Sprotte, Bennett, Chapman, Chase, Sherburne	Report prepared for 1977-1978 geophysical work.
Foothills fault system	Bennett	Releveling was completed across the Bear Mountain fault zone. Report prepared for CALIFORNIA GEOLOGY.
Telluric current-self potential	Durrwachter, Bacon	Operating 3 arrays on San Andreas fault, central California.
Crustal movement studies near Parkfield	Bacon, Bennett, Chase, Toppozada	Continued monitoring geophysical data.
Microacoustic survey	Durrwachter, Bacon	Operations 5 stations; Palmdale-Parkfield along San Andreas fault.
Gravity map sheets of California,Scale 1:250,000	Chapman, Chase, Campbell	In press: Needles sheet; in preparation: Fresno, revised Santa Cruz, Long Beach, Santa Maria, Salton Sea, Mariposa sheets.
Gravity map of California Scale 1:750,000	Chapman, Chase, Campbell	Map completed; text being written.
Aeromagnetic map of California, Scale 1:750,000	Chase	Index map being updated for publication in CALIFORNIA GEOLOGY.
Port Wine area study	Chapman, Clark	Report in progress.
Bodie mining district	Chesterman, Gray, Chapman	Geophysical section of report completed.

Gravity leveling study, Parkfield, Palmdale	Chase, Chapman, Real, Campbell	Continued monitoring of selected stations for changes in gravity; evaluation of data.
USGS coop aeromagnetic survey-offshore California	Chapman	Survey released as USGS Open-File Report 77-79.
Kelly Hot Springs geothermal investigation	Chapman, Bacon	Released as Open-File Report 78-5 SAC.
Ground water of western Placer County	Chapman	Report released as Open-File Report 77-10 SAC.
Pasadena-Palmdale (cooperative with Cal Tech)	Chapman, Chase	Monitoring selected stations for changes in gravity.

III. Minerals Program

Division activities under the Minerals Program include: (1) The Surface Mining and Reclamation Act (SMARA); (2) Mineral Commodities Investigations, and (3) Geothermal Resources Studies.

1. Surface Mining and Reclamation Act (SMARA)

a. Classification of mineral lands

The 1975 Surface Mining and Reclamation Act required local government to consider mineral resources in areas identified by the Office of Planning and Research as a part of land-use planning. Mineral lands are being classified on a priority basis by the State Geologist, and some lands will be designated by the State Mining and Geology Board to be of state, regional, or local significance.

To implement the mineral aspects of the Surface Mining and Reclamation Act of 1975, a short pilot project to study the sand and gravel resources of the Stanislaus River area was completed at the request of the State Mining and Geology Board. This study served as an exercise in identify problems in classifying similar mineral deposits throughout the state. During fiscal year 1977-78 major classification studies were initiated in the greater Los Angeles area and in the southern San Francisco Bay area counties.

b. Mine reclamation

The Division's major concern with the mine reclamation aspects of the 1975 Surface Mining and Reclamation Act during this fiscal year involved compiling data relative to existing mines and providing technical assistance to local government in implementing the Act.

Specific Project Status and Staff Participation

Project	Staff	Status
Los Angeles area SMARA land classification	Anderson, Bushnell	Mineral Resource Zones (MRZ) completed. Identified production marketing area.
San Francisco Bay counties SMARA land classification	Stinson, Burtugno, Manson	Completed zoning of Alameda County and parts of Santa Clara County.
Stanislaus River SMARA land classification	Burnett, Rapp, Loyd	Completed pilot study.
Surface mine permits/ reclamation plans	Anderson, Bushnell, Loyd, Stinson, Bortugno	Technical assistance to lead agencies.

2. Mineral commodity investigations

a. Sand and gravel

A study of the sand and gravel aggregate resources of the San Francisco Bay area counties, funded largely by a grant from the U.S. Bureau of Mines (USBM), was initiated during fiscal year 1976-77. Work was completed in a draft report of this study during the year. The objective of the project was to gather and analyze data on ownership, operation, production, marketing, extraction, processing, transportation, land use, and environmental considerations for all active aggregate producers and ready-mix plants within the San Francisco Bay region. A previous report on the aggregates industry in the greater Los Angeles area was transmitted to the USBM early in fiscal year 1976-77 and released as Open-File Report 77-1 LA.

b. Uranium

A mineral commodity investigation was initiated to identify the source and origin of uranium mineralization in the vicinity of the Juniper mine near the crest of the Sierra Nevada in Tuolumne County. This study will combine chemical and economic geologic disciplines.

In May 1978 a second uranium investigation in cooperation with the Department of Energy was initiated as a part of that agency's National Uranium Resource Evaluation (NURE) program. The study is a uranium favorability evaluation of the Trona quadrangle (map scale 1:250,000).

c. Chromite

A continuation of a study of the State's chromite deposits in specified areas was completed, but the program was terminated due to lack of staffing.

Specific Project Status and Staff Participation

Project	Staff	Status
San Francisco region aggregate	Chesterman, Manson, Stinson	Completed in draft form.
Juniper mine area Uranium	Rapp, Majmundar	Continuing data collection.
Chromite	Smitter	Sacramento District studies completed.
Trona quadrangle, NURE	Morton, Bushnell	Phase I begun.

3. Geothermal resource studies

The Division negotiated a contract with the U.S. Department of Energy (DOE) to perform a statewide resource assessment of low and moderate temperature geothermal resources. This program is planned to continue for three or more years with DOE funding at about $200,000 to $250,000 per year. The program will include two phases: Phase I will involve data collection/inventory work and production of geothermal maps of California, and Phase II will consist of site-specific or reservoir confirmation studies. The contract was signed in the last month of the fiscal year. A full-time project manager, two geologists and three student assistants were assigned to process geothermal data for early input to the DOE and the U.S. Geological Survey GEOTHERM data bank. Geologic and geophysical studies were also started at Bridgeport in cooperation with Caltrans. The multiagency geothermal task force completed its work, and preparation of a final report began.

Specific Project Status and Staff Participation

Project	Staff	Status
California/DOE Resource Assessment Program		Beginning June 1978.
Management	Martin, Bacon	
Bridgeport study	Chapman Chase	
Phase I investigation	Higgins Taylor Hitchman Levine Huntley	
Geothermal task force	Bacon	Completed, Disbanded.

Photo 4. Geothermal resources, The Geysers; looking north along the northeastern banks of Big Sulphur Creek. Pacific Gas and Electric Company Power Plant Units 3 and 4 (center left) and Units 5 and 6 (center right) generate electricity from natural stream. Photo courtesy of Division of Oil and Gas.

IV. Basic Geology Program

The Division's basic geology activities are geochemical analysis, areal geologic mapping and geologic compilation fundamental to mineral resource, engineering geology, and general land-use analyses. The basic objective is to understand and describe the distribution and physical properties of rock units so that the State may advise in matters concerning the geology of any part of the State. Among other results, such investigations have assembled most of the available information concerning the location of faults in California and their relative activity.

Currently, the geologic mapping in progress is for environmental geology investigations rather than basic geologic mapping per se. The mapping listed under the geologic hazards program will serve as basic geologic mapping.

The Geologic map of California, scale 1:750,000 was published in fiscal year 1977-1978. An index and explanation of source data used to compile the State geologic and fault maps, scale 1:750,000, are in progress. The revised Death Valley geologic map sheet, scale 1:250,000, was published in June 1978.

The Division of Mines and Geology has participated in the establishment of the California Well Sample Repository -- which is located on the campus of California State College, Bakersfield -- and continues to provide it with economic support and advisory guidance. This repository is the first public facility of its kind in California and fulfills a long recognized need to assemble, process and preserve, catalog, and make available for public use,

a collection of rock samples representative of the geologic history, stratigraphic sequences, rock properties, and mineral resources of the State of California.

The repository is operated by the California State College, Bakersfield, Foundation, with the guidance and support of an Advisory Committee composed of representatives from the petroleum industry, professional scientific societies, institutions of higher education, and state and federal government. The Division is represented on this Advisory Committee, and during fiscal year 1977-78 the Division provided $5,000 for the repository's operation and maintenance. Energy and mineral resource development based on investigative studies of rock materials assembled at this repository will result in manifold benefits to the people of California.

Specific Project Status and Staff Participation

Project	Staff	Status
Subsurface data collection	Sprotte	Data is collected for use in various projects, mainly in Los Angeles Basin.
Index to geologic maps, 1969-75	Kiessling	Indexing completed and submitted for publication processing.
Death Valley sheet of the State geologic map, scale 1:250,000	Streitz, Stinson	Published.
Index and explanation of source data used to compile State geologic and fault maps, scale 1:750,000	Jennings	In preparation.
Index to graduate Theses and Dissertations on California geology, 1973 and 1974	Peterson, Saucedo	Published in February 1978 CALIFORNIA GEOLOGY.
State geologic map, Scale 1:750,000	Jennings	Published as California Geologic Data Map Series, Map No. 2.
State geologic map, scale 1:250,000	Jennings	Planning for new series (Sacramento and Santa Rosa sheets).

The Division's geochemical section provides support to other Division project activities and independent projects of the geochemical staff. During this fiscal year considerable effort was directed toward analyzing samples for chromite and uranium projects. Existing analytical procedures were improved. Clay mineral studies relative to slope stability continued.

Specific Project Status and Staff Participation

Project	Staff	Status
Physical testing of soils for urban development	Borchardt	Report published in November 1977 CALIFORNIA GEOLOGY.
Clay mineralogy and slope stability	Borchardt, Lofgren, Loza	Report prepared and submitted for publication.
Physical testing of soil and sediment samples from Auburn Dam Review Project	Majmundar, Loza	Investigation in progress.
Clay mineralogy determination of soil and sediment samples by x-ray diffraction, from Auburn Dam Review Project	Majmundar, Loza	Investigation in progress.
Ca:Fe ratio determination in samples from Auburn Dam Review Project	Majmundar, Borchardt, C. Smith	Calcium and iron being determined by x-ray fluorescence. Investigation in progress.
Procedure development for Ag, Al, As, Au, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Na, Ni, Pb, Zn	Majmundar, C. Smith	Atomic absorption spectrophotometric procedures for these elements (at trace concentrations) are being improved and new procedures are developed.
Trace elements in stream sediments, Monterey County	Majmundar	A summary of Open-File Report 77-5 SF was published in the October 1977 CALIFORNIA GEOLOGY.
Arsenic, cadmium, copper, lead, mercury, and zinc in stream sediments from Monterey County	Majmundar	Report prepared for publication.
Radiometric equivalent analysis of core samples obtained from Lucky Mc Uranium Company, Reno, Nevada	Majmundar, Borchardt, C. Smith, Rapp	Investigation in progress.
Physical testing of soil and sediment samples	Borchardt, Majmundar, Lofgren	Used physical tests on sedimentary materials (particle size distribution and Atterberg tests); bulk and clay mineralogy determination by x-ray diffraction.

V. Geologic Information Program

1. Publications

Information on the geology, mineral resources, and geologic hazards of California is published and distributed by the California Division of Mines and Geology (CDMG) to professionals and interested lay-persons. The results of studies made by staff members of the Division and others in the earth sciences professions are published in the Division's monthly magazine CALIFORNIA GEOLOGY, bulletins, special reports, map sheets, special publications, and preliminary reports.

The publications staff reviewed the technical content of manuscripts, drafted illustrations and maps, edited manuscripts and maps, coordinated printing and lithography, negotiated printing contracts, managed the printing budget, and supervised the distribution of the final printed reports. Revenue from the sale of Division publications during fiscal year 1977-78 was $136,808.

News releases concerning the Division's publications are prepared and distributed to the media. Thousands of inquiries received annually by the Division are answered by supplying copies of the CDMG Notes, CALIFORNIA GEOLOGY, and occasionally by individual letter from a member of the technical staff.

An information and publication sales desk is maintained at each of the District offices. The Division's library and mineral exhibit at the San Francisco District office also help to inform the public of the importance of geology to the economy of California.

a. New publications released

- Geologic Map of California (Geologic Data Map No. 2). Compiled by C.W. Jennings with assistance from R.G. Strand and T.H. Rogers. Flat, $8.00, rolled, $9.50; uncolored, $5.50 (with topography; without topography).

Published as a single sheet at 1:750,000 scale (1 inch = 12 miles), this 4 1/2 x 5 foot map is an ideal size for wall display. It was created as a ready reference tool of high quality for use by public officials, industry, libraries, consultants, students, and educational institutions seeking information on the geology of California. Its bright colors permit easy recognition, even at a distance, of the most prominent rocks and structures found in the state. Besides indicating rock types and their distribution, the map clearly depicts faults, folds, and volcanoes. For the first time on a state geologic map of this relatively large scale, offshore geologic structure is shown. The map represents the culmination of nearly 10 years of careful and extensive research involving the cooperation of numerous State and federal agencies, academic instituions, private geological firms, and consultants.

• Bulletin 202. Geology of the Point Reyes peninsula, Marin County, California, by A.J. Galloway. $4.00.

Bulletin 202 describes the geology of the Point Reyes peninsula. The report is a comprehensive report for the geologist and a source of information for the interested layman.

The Point Reyes peninsula is divided from the Coast Ranges of the mainland by a long straight depression extending from Tomales Bay to Bolinas Lagoon. This depression, called the Olema trough, marks the trace of the San Andreas fault. The 1906 fault rupture along the San Andreas fault can still be identified today. The greatest measured horizontal movement in the 1906 earthquake took place near the town of Point Reyes Station, where the offset amounted to 20 feet.

The Point Reyes peninsula is underlain by upper Cretaceous granitic rocks. These granitic rocks, which contain roof pendants of schist and marble, crop out principally along Inverness Ridge and Point Reyes. The granitic rocks are overlain by Tertiary and Quaternary sedimentary rocks west and south of Inverness Ridge. Rocks of the Franciscan assemblage are found east of the San Andreas fault.

In addition to the lithology of the area, Bulletin 202 describes the geography, structure, geomorphology, geologic history, and economic geology of the Point Reyes peninsula. A colored geologic map printed on a topographic base map (scale 1:48,000) and one geologic cross section are also included.

• County Report 7. Mines and mineral resources of Imperial County, by P.K. Morton. $8.50.

Imperial County comprises 4,284 square miles of southeasternmost California. Within its boundaries are portions of three provinces, each distinct in its geological and physiographic characteristics. The northeastern half of the county is underlain by rocks ranging in age from pre-Cretaceous to Quaternary. Imperial Valley, in the Salton Trough (formerly called Colorado Desert) province, is covered predominantly by Quaternary lakebeds, sand dunes, and alluvium which overlie Tertiary non-marine sedimentary and volcanic rocks. A large northwest-trending structural fabric has developed in most of the county; this is especially reflected by the San Andreas, Elsinore, San Jacinto, and related fault systems, which traverse the central and western parts of the county.

The total estimated value of mineral production in the county from 1880 through 1968 exceeds $74 million. Gypsum, sand and gravel, gold, manganese, carbon dioxide, pumice, and crushed stone account for the bulk of the production. A geologic map (scale 1:125,000)showing location of mines and mineral deposits is included in the report.

Of possible future importance is the natural steam from geothermal fluids beneath portions of the county. The geothermal resources are being

investigated for generation of electric power and the recovery of minerals and fresh water from superheated brines.

- County Report 8. Mines and mineral resources of Alpine County, by W.B. Clark. $3.50.

The report describes the geology, mines, and mineral deposits of Alpine County in the Sierra Nevada. A geologic map (scale 1:125,000) showing location of mines and mineral deposits is included in the report.

The county is underlain principally by volcanic and granitic rocks. Some metamorphic rocks occur as pendants in the northern part of the county. Most of the Alpine County terrain was shaped by glaciers, and some glacial moraines are found in the southwest part of the county.

Mineral deposits include sulfur, gold, silver, copper, tungsten, sand and gravel, and stone. Other commodities found in the county include lead, zinc, mercury, arsenic, manganese, and minerals of interest to collectors.

- Special Report 131. Recency of faulting along the Elsinore fault zone in southern Riverside County, California, by M.P. Kennedy. $2.50.

Special Report 131 presents the findings of a two-year evaluation of the recency and character of faulting along the Elsinore fault zone between Wildomar and upper Wolf Valley. This segment of the Elsinore fault zone forms a pronounced structural and topographic boundary between the Santa Ana Mountains and the Perris block. The fault zone consists of a geometrically complex group of faults that have both lateral and vertical slip components. These faults constitute two major zones, the Willard fault zone on the west and the Wildomar fault zone on the east that bound the alluvium-filled Elsinore trough.

The study was made in order to gather geologic data necessary to assign a maximum and minimum age to this segment of the Elsinore fault zone, and to assess the overall length of individual faults within this segment of the fault zone.

A 1:24,000 scale geologic map, printed on a sepia toned base covering the area investigated is included in the report.

- Special Report 134. Erosion along Dry Creek, Sonoma County, California, by G.B. Cleveland and F.R. Kelley. $3.00.

This report analyses the rapid erosion that has occurred near Healdsburg in the lower 15 mile reach of Dry Creek, a tributary to the Russian River. In the broad span of geologic time these events are normal and expected. But occurring as they have, within a relatively few years and in an area where the effects can be readily measured by the number of orchard trees lost, the situation appears ominous. Because of the long term changes in land use in

this region and the random occurrence of fires and floods, bank erosion will occur periodically from place to place along lower Dry Creek.

This unique study evaluates all available scientific data from many disciplines (geology, hydrology, forestry) to analyze a complex interrelated geoenvironmental problem. The method of investigation illustrates what can be done by careful observation and use of data from related disciplines. The report provides a good example of this type of investigation for use in classroom instruction in geohydrology and environmental studies.

- Map Sheet 29. Geology of the National City, Imperial Beach, and Otay Mesa quadrangles, southern San Diego metropolitan area, by M.P. Kennedy and S.S. Tan. $6.00.

MS 29 is a colored geologic map on a topographic base (scale 1:24,000), with symbols printed in black. The map sheet shows the La Nacion fault zone and geologic formations. Descriptions of the geologic units, which range in age from upper Jurassic to Holocene, are printed on the map sheet. Geologic and geophysical field investigations were conducted during the period 1966-1975.

- Map Sheet 37. Geology of the Haiwee Reservoir 15-minute quadrangle, Inyo County, California, by M.C. Stinson. $3.50.

MS 37 is a colored geologic map on a topographic base (scale 1:62,500), with symbols printed in black. Four geologic cross sections are included. The map depicts the geology of an area of approximately 250 square miles, and includes the southern portions of Owens Valley and Rose Valley, as well as the western portion of the Coso Range. Lithologic descriptions of the geologic units, which range in age from Mesozoic to Holocene, are printed on the map sheet.

- Map Sheet 38. Geology of the Keeler 15-minute quadrangle, Inyo County, California, by M.C. Stinson. $3.50.

MS 38 is a colored geologic map on a topographic base (scale 1:62,500), with symbols printed in black. Five geologic cross sections are included. The map depicts the geology of an area of approximately 250 square miles, and includes the eastern and southern portion of Owens Lake and the northern portion of the Coso Range. Lithologic descriptions of the geologic units, which range in age from Pennsylvanian to Holocene, are printed on the map sheet.

- Geologic Atlas of California, scale 1:250,000.
  Death Valley sheet (revised).
  Colored, $2.50; uncolored, $1.50.

•Sixty-Ninth Report of the State Geologist (1975-1976). No charge.

This report describes the programs of the California Division of Mines and Geology concerning mineral resources, geological hazards, seismology, geophysics, geochemistry, marine geology, basic geology, fault evaluation, strong-motion instrumentation, environmental impact and hospital review, publications, and information service to earth sciences professionals and the public.

•Supplement No. 2 to Special Publication 42, January 1977 edition. No charge. This supplement announces the Pitas Point quadrangle map as an official special studies zone (issued January 1, 1978).

•Earthquake Catalog of California - Magnetic tape. $45.00.

b. Publications reprinted

Bulletin 183. Franciscan and related rocks and their significance in the geology of western California, by E.H. Bailey, W.P. Irwin, and D.L. Jones. $5.00.

Bulletin 190. Geology of northern California, edited by E.H. Bailey. $9.00.

Bulletin 191. Mineral resources of California. $3.00.

Special Report 52. Index to geologic maps of California to December 31, 1956, by R.G. Strand, J.B. Koenig, and C.W. Jennings. $2.75.

Special Report 102. Index to geologic maps of California, 1965-1968, by E.W. Kiessling. $2.75.

Special Report 125. Mines and mineral deposits in Death Valley National Monument, California, by J.R. Evans, G.C. Taylor, and J.S. Rapp. $3.50.

Map Sheet 23. Maximum credible rock acceleration from earthquakes in California, by R.W. Greensfelder. $1.50. Scale 1:2,500,000.

Special Publication 42. Fault hazard zones in California (revised January 1977) with Supplement No. 2 included, by E.W. Hart. $1.00.

Special Publication 48. Second report on the Strong Motion Instrumentation Program. $1.00.

Special Publication 51. State policy for surface mining and reclamation practice, by State Mining and Geology Board. No charge.

The following reprints of the Geologic Atlas of California, scale 1:250,000, were released:

Chico sheet	San Bernardino sheet
Fresno sheet	San Diego-El Centro sheet
Los Angeles sheet	Santa Cruz sheet
Redding sheet	Santa Maria sheet
Salton Sea sheet	Weed sheet

Colored, $2.50 per sheet; uncolored, $1.50.

Geologic map of California. Scale 1:2,500,000. $1.00.

c. CALIFORNIA GEOLOGY

Major articles published in the monthly magazine were:

Socioeconomic impact of earthquake prediction on government, business, and community.
Earthquake prediction evaluation guidelines.
Topanga Beach, geology at the shoreline.
Manix fault zone.
Geology for timber harvest planning.
Rapid erosion along the Eel River.
Influence of geologic hazards on legislation in California.
Review process and adequacy of geologic reports.
Pleistocene Lake Yosemite and the Wisconsin glaciation of Yosemite Valley.
Ice Age geomorphology, Middle Fork San Joaquin River, Madera County.
Physical testing of soils for urban development.
Marble Cone fire, effect on erosion.
Earthquake safety for homes.
Diatomite industry in California.
Whitney Glacier, record of a climb.
Ground water, California's precious resource.
Airfield fault, Mesquite Playa, San Bernardino County.
Private mints in California.
New geologic map of California, summation of 140 years of geologic mapping.
Pleistocene river erosion and intracanyon lava flows.
Historic earthquakes, effects in Ventura County.
Klamath River geology, Curley Jack Camp to Ti Bar.
Raymond Hill fault, an urban geological investigation.
Earthquake recurrence intervals, San Andreas fault, Palmdale, California.

d. Revised CDMG Notes

CDMG Note 32. Assessment work on mining claims.

e. Open-file reports

Reports of Division investigations are released on open-file to make the data available as soon as possible after the studies are completed. This enables interested professional geologists and other users to obtain the data

prior to formal publication. The following reports were released on open-file during fiscal year 1977-78:

OFR 77-4 LA. Seismic hazards related to geologic factors, Elsinore and Chino faults, northwestern Riverside County, California, by F. Harold Weber Jr. The report includes a text and geologic activity maps. The study was made as part of the Earthquake Hazards Reduction Program. The primary conclusion is that the entire length of the Elsinore and Chino fault zones within the study area appear to have been active during late Quaternary time.

OFR 78-1 LA. Preliminary fault map, east half Quail Lake segment, San Andreas fault zone, Los Angeles County, California, by J.E. Kahle. An annotated fault map (orthophoto base, scale 1:12,000), depicting faults and fault features inferred to be related to recent surface faulting, is accompanied by an explanatory text.

OFR 78-2 LA. Preliminary fault map of the Lake Hughes segment, San Andreas fault zone, Los Angeles County, California, by David J. Beeby. The abundance and freshness of geomorphic fault features preserved along this segment testify to the recency of movement. The area is mapped on an orthophoto base at a scale of 1:12,000.

OFR 78-3 LA. Preliminary fault map of the Valyermo segment, San Andreas fault zone, Los Angeles County, California, by A.G. Barrows. An annotated fault map on orthophoto base (1:12,000) depicts faults and fault features inferred to be related to recent surface faulting.

OFR 77-5 SF. Trace elements in stream sediments, Monterey County, California, by H.H. Majmundar. The geochemical study on this interagency public health project had as its objectives (1) the development of accurate techniques to sample the stream sediments of the project area, (2) the development of analytical procedures to detect very small proportions of arsenic, cadmium, and mercury; and (3) the preparation of maps showing the distribution of arsenic, cadmium, copper, lead, mercury, and zinc in the stream sediments of Salinas Valley.

OFR 77-8 SF. Fault evaluation program, 1976 Area (Western Transverse Ranges), by Earl W. Hart, Edward J. Bortugno, and Theodore Smith. This study is part of the overall program in which potentially active faults are being evaluated with respect to the potential hazard of surface fault rupture. Faults considered to have a relatively high potential for future activity and having reasonably well-identified surface traces are recommended for regulatory zoning under the Alquist-Priolo Act.

OFR 77-13 SF. Environmental geologic analysis of the Porter Creek study area, Sonoma County, California, by C.F. Armstrong. Geologic hazards are identified and mapped.

OFR 77-15 SF. Geology for planning in western Marin County, California, by D.L. Wagner. Geologic hazards are identified and mapped.

OFR 78-11 SF. Environmental geologic analysis of the Diablo Range, study area I, southern Santa Clara County, California, by C.F. Armstrong and D.L. Wagner. Scale 1:12,000. This study was conducted by the Division in cooperation with Santa Clara County (see also OFR 78-12 SF). The study area, comprising approximately 14 square miles, is located in the west central portion of the Diablo Range, east of the town of Gilroy. Geologic features that constitute potential hazards to public safety and future development of the area, such as slope stability, fault rupture, and seismic response problems, are identified and analyzed. The report includes a geologic map, a landslide and slope stability map, and a fault activity and seismic response map (all at 1:12,000).

OFR 78-12 SF. Environmental geologic analysis of the Diablo Range, study area II, southern Santa Clara County, California, by D.L. Wagner. Scale 1:12,000. This study was conducted by the Division in cooperation with Santa Clara County, and is a companion study to OFR 78-11 SF. The study area, comprising approximately 14 square miles, is located in the west central portion of the Diablo Range, east of the town of Morgan Hill. Geologic features that constitute potential hazards to public safety and future development of the area, such as slope stability, fault rupture, and seismic response problems, are identified and analyzed. Mineral resources, geologic resources (including waste disposal and ground water potential), and seismicity of the study area are also discussed. The report includes a geologic map, a landslide and slope stability map, and a fault activity and seismic response map (all at 1:12,000).

OFR 77-11 SAC. A microearthquake survey of the Rocklin-Penryn pluton in the Sierra Nevada foothills west of Auburn California, by C.H. Cramer, R.W. Sherburne,T.R. Toppozada, and D.L. Parke. This report presents the detailed results of seismic monitoring and covers current seismic activity in the vicinity of the pluton, the results of a shallow refraction study, and a review of historical earthquake activity in the area.

OFR 77-16 SAC. A mineral land classification study of the Stanislaus River area, San Joaquin and Stanislaus Counties, California, by J.S. Rapp, R.C. Loyd, and M. Silva. Scale 1:48,000. The Division, pursuant to Resolution No. 16 of the State Mining and Geology Board, has conducted a pilot study to classify the sand and gravel resources along the lower Stanislaus River. This pilot study was designed to develop and test methodology, investigative techniques, and staff time requirements to classify land based on its context of mineral deposits following the State Mining and Geology Board's Guidelines for classification and designation of mineral lands.

OFR 77-17 SAC. Principal facts and sources for 1,820 gravity stations on the Alturas 1°x 2° quadrangle, California, by R.H. Chapman, C.C. Bishop, and G.W. Chase. Basic data for the stations are given, and the locations are plotted at a map scale of 1:250,000. Complete Bouguer anomalies have been computed for all stations.

OFR 77-18 SAC. Principal facts and sources for 666 gravity stations on the Needles 1°x 2° quadrangle, California, by R.H. Chapman, J.D. Rictman, and S.J. Biehler. Basic data for the stations are given, and the locations are plotted at a map scale of 1:250,000. Complete Bouguer anomalies have been computed for all stations.

OFR 78-4 SAC. Earthquake epicenter map of California showing events from 1900 through 1974 equal to or greater than magnitude 4.0 or intensity V, by C.R. Real, T.R. Toppozada, and D.L. Parke. Scale 1:1,000,000. There are 2,157 separate epicenter locations plotted on this map representing 3,348 earthquakes (Figure 3). A list of the 364 events equal to or greater than magnitude 5.0 is also shown.

OFR 78-5 SAC. Preliminary results of a gravity survey in the Kelly Hot Spring area, Modoc County, California, by R.H. Chapman, G.W. Chase, and G.C. Taylor. Scale 1:62,500. The report includes a Bouguer gravity anomaly map of the area, and the results of both a 2-dimensional (profile) analysis and a 3-dimensional analysis of the gravity data in terms of possible geologic structure.

2. Library

The Division's library, located at the San Francisco office, is open to the public for reference reading and research use. During the year the rare books room was cleaned out, the cataloging of U.S. Government publications and U.S. Geological Survey publications was completed. Cards were prepared for the Los Angeles District Office library, and similar work was started for the Sacramento District office. A new card catalog cabinet was received and put into use. All cards are now sent to DABC, Inc. for duplication. An additional card catalog cabinet and a new microprint reader-printer were ordered at the end of the year. Many new books were received throughout the year.

3. Mineral exhibit

The mineral exhibit, located on the second floor of the Ferry Building in San Francisco, is open to the general public on weekdays, Monday through Friday, from 8:00 a.m. to 5:00 p.m. Tourists as well as students and professionals have shown an increased interest in the exhibit this year.

Museum-quality specimens have been donated by individuals, mineral groups, and mineral dealers. A San Francisco mineral group, The Crystal-Gazers, donated funds for the Dana display, and several fine specimens were supplied at cost by a local dealer. A new opal display has been completed, and much interest has been shown by viewers. An unusual donation consisted of a large map of California showing areas where jade and pseudo-jade have been found. These areas are marked on the map with examples of uncut rough, and cut and polished jade cabochons.

Summer student assistants have updated the mines' file, made new index marker cards, washed and waxed the floor in the display area, cleaned and sorted material in the curatorial rooms, and cleaned display cases.

The Division's gold facsimiles were displayed (by invitation) at the California Federation of Mineral Societies show at Pleasanton, California. The Division provided an information table at the second annual Bay Area Environmental Education Resources Fair at Merrit College in Oakland. Talks were given to the Vallejo Gem and Mineral Society and the Galileo Gem and Mineral Society. Various news media and authors were given gold information and allowed to take slides of the gold specimens. Cooperation was given to a member of the U.S. Geological Survey and the Attorney General's office on a case involving a supposed theft of gold from the Oriental Mine, Sierra County, California.

Photo 5. Mineral exhibit, San Francisco District. Photo by Jeanne Demouthe Smith.

ADMINISTRATION AND ORGANIZATION

The Division of Mines and Geology was organized as shown in Figure 4 from May 1, 1977 to March 20, 1978. On March 21, 1978, James F. Davis assumed the position of State Geologist, Thomas E. Gay, Jr. resumed his former position of Chief Deputy State Geologist, and John T. Alfors resumed his former position of Supervising Geologist.

On May 8, 1978 John T. Alfors was assigned to be District Geologist of the Sacramento District Office, and Perry Y. Amimoto was transferred to the Division headquarters as Advisory Services Officer in charge of the Division's review and advisory services functions. The title Deputy for Administration and Planning was abolished, and Rudolph G. Strand was designated the Special Programs Officer in overall charge of the Division's minerals programs including the geothermal program, the Office of Strong Motion Studies, the publications program, the Surface Mining and Reclamation program, and administrative services.

As of June 30, 1978, the end of fiscal year 1977-1978, the organization chart reflecting these changes had not been finalized.

I. Districts

The Division's programs are carried out primarily through three district offices located in Los Angeles, San Francisco and Sacramento. The areas of responsibility of each of these districts are shown in Figure 5.

1. Los Angeles

The Los Angeles District serves all of southern California. The District comprises eleven counties bounded on the north by, and including, the counties of San Luis Obispo, Kern, and Inyo. The District office is located in the Junipero Serra Building at 107 South Broadway in the Los Angeles Civic Center.

The District staff includes 20 geologist, 1 geologic aid, 2 drafting technicians, 4 secretaries, and 4 temporary student assistants. Four small field offices are maintained near projects. Currently field offices are located in San Diego, San Luis Obispo, Santa Ana, and on the UCLA campus. The Los Angeles District maintains a public information center as well as a small technical library.

The bulk of the project work of the District involves cooperative investigations with local counties and with the U.S. Geological Survey, and is concerned primarily with geologic hazards and environmental geology as it relates to proper land use. During the current year these investigations have concentrated heavily upon active and potentially active faults. A special hazards study was initiated to investigate the nature and the extent of the effects of the landslides that seem to have been triggered by torrential February and March 1978 rains in the Los Angeles region. Mineral resources studies received new emphasis and were accelerated with the initiation, under the Surface Mining and Reclamation Act, of the classification of mineral lands in portions of the greater Los Angeles area.

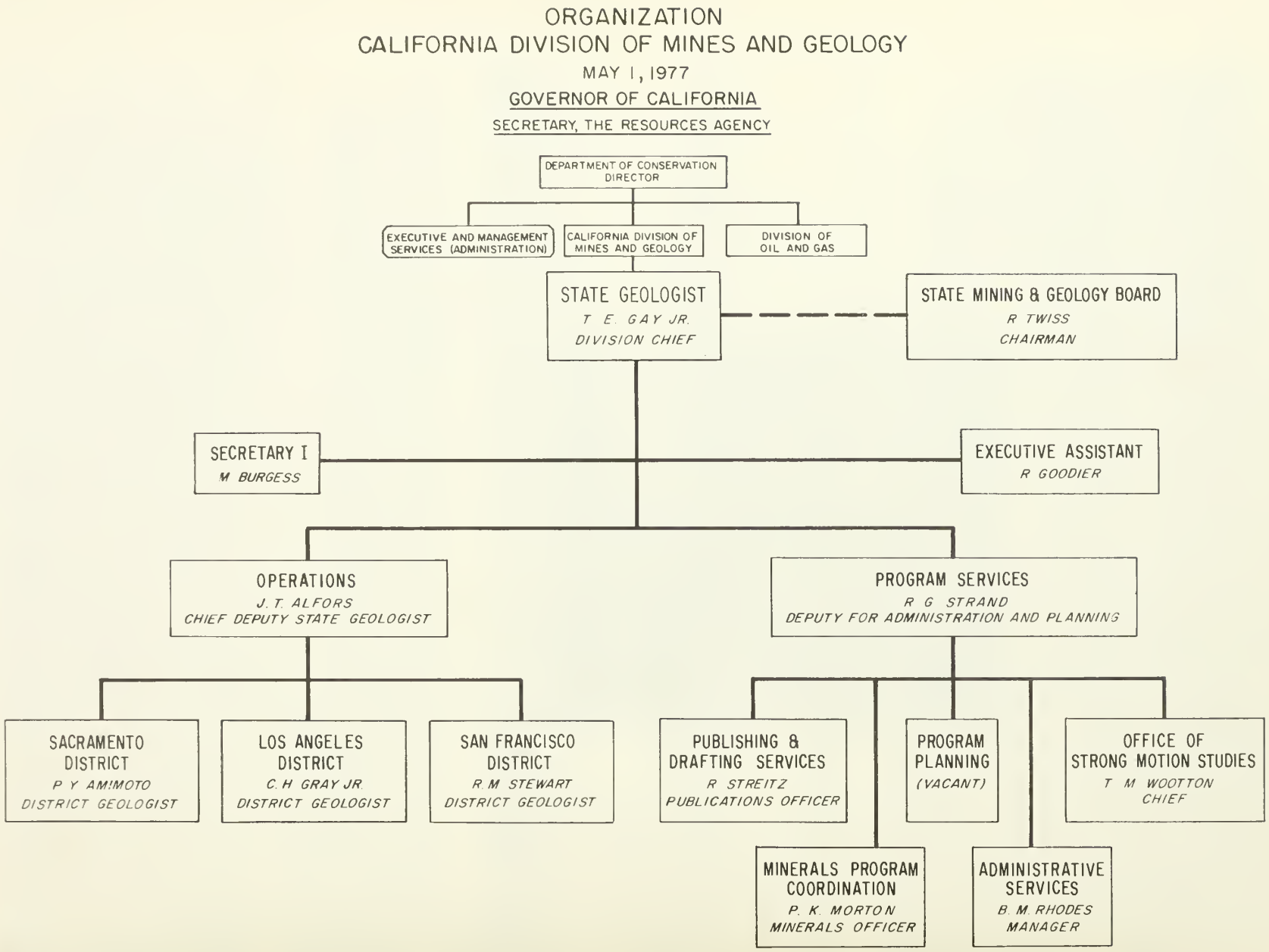

Figure 4. Organization of California Division of Mines and Geology (May 1, 1977 to March 20, 1978).

2. Sacramento

The Sacramento District office, located at 2815 "O" Street in Sacramento, provides geologic services to thirty counties in central inland and northeastern California. In addition, this District office provides geophysical and seismological services to the entire State.

District efforts have focused on studies of crustal deformation and seismicity. One important goal of these studies is the identification of precursors to damaging earthquakes so that an earthquake-warning system can be developed. Geological work has emphasized mineral resources and the evaluation of environmental considerations in land development.

The Sacramento District staff consists of 10 geologists, 3 geophysicists, 5 seismologists, 3 geologic aids, 3 secretaries, and 1 geologic drafting technician. In addition the District has had the services of several student assistants during fiscal year 1977-1978.

Photo 6. Seismographs and map display, Sacramento District office. Photo by Gregg Chargin.

3. San Francisco

The San Francisco District office, which has been housed in the historic Ferry Building since 1896, covers a working territory of seventeen counties in northern and central coastal California. This includes approximately two-thirds of the California seacoast, most of the central and northern Coast Ranges, and much of the very active San Andreas fault and related faults.

Several Division-wide facilities exist in this District office. They are the geochemical laboratory, which provides analytical and testing support to the Division staff; the map room, in which are compiled and prepared various maps such as the Geologic Map of California series; the Division's large and complete technical reference library; and one of the largest mineral exhibits on the west coast.

Figure 5. California Division of Mines and Geology, Districts.

Investigations and studies conducted from this office during fiscal year 1977-78 included cooperative projects with various San Francisco Bay area counties, the Alquist-Priolo Special Studies Zones program concerning geologic hazards and seismic safety, and mineral resources activities.

Authorized District staff consisted of 16 geologists, 1 geochemist, 1 geochemist-soil mineralogist, 3 laboratory technicians, 2 geologic aids, 3 geological drafting technicians, 1 librarian, 1 library technical assistant, 5 secretaries and clerks, 1 information clerk and 1 janitor.

II. Personnel

James F. Davis was appointed State Geologist on March 21, 1978. Thomas E. Gay, Jr., who had been serving as State Geologist since October 1975, resumed his former classification of Chief Deputy State Geologist. John T. Alfors after serving as Chief Deputy State Geologist since April 1, 1977, resumed his former classification of Supervising Geologist.

On May 8, 1979 John T. Alfors was assigned to the position of District Geologist in charge of the Sacramento District, Perry Y. Amimoto was assigned to the position of Advisory Services Officer in Division headquarters and Rudolph G. Strand was assigned to the position of Special Programs Officer in Division headquarters.

Permanent Division Staff Members, June 30, 1978

Classification	Employee	Location
State Geologist	James F. Davis	Headquarters
Chief Deputy State Geologist	Thomas E. Gay Jr.	Headquarters
Special Programs Officer, Supervising Geologist	Rudolph G. Strand	Headquarters
Executive Assistant, Supervising Engineer	Robert D. Goodier	Headquarters[1]
Advisory Services Officer, Supervising Geologist	Perry Y. Amimoto	Headquarters
Strong Motion Studies, Officer, Senior Geologist	Tom M. Wootton	Sacramento
Minerals Officer, Senior Geologist	Paul K. Morton	Los Angeles
Publications Officer, Senior Geologist	Robert Streitz	Headquarters
Program Planning Officer, Associate Governmental Program Analyst	Zoe K. Mankoski	Headquarters
District Geologist, Supervising Geologist	Cliffton H. Gray, Jr.	Los Angeles
Assistant District Geologist, Senior Geologist	F. Harold Weber, Jr.	Los Angeles
District Geologist, Supervising Geologist	John T. Alfors	Sacramento

Classification	Employee	Location
Assistant District Geologist, Senior Geologist	C. Forrest Bacon	Sacramento
District Geologist, Supervising Geologist	Richard M. Stewart	San Francisco
Assistant District Geologist, Senior Geologist	Charles C. Bishop	San Francisco
Senior Geologist	Carl J. Hauge	Headquarters[2]
Senior Geologist (Geophysics)	Rodger H. Chapman	Sacramento
Senior Geologist	Charles W. Chesterman	San Francisco
Senior Geologist	Earl W. Hart	San Francisco
Senior Geologist	Charles W. Jennings	San Francisco
Senior Geologist	George B. Cleveland	San Luis Obispo
Senior Marine Geologist	Michael P. Kennedy	San Diego
Petroleum Geologist	Edward C. Sprotte	Los Angeles
Senior Seismologist	Roger W. Sherburne	Sacramento
Senior Structural Engineer	John T. Ragsdale	Sacramento
Associate Geologist	William B. Clark	Headquarters
Associate Geologist	Mary C. Woods	Headquarters
Associate Geologist	Thomas P. Anderson	Los Angeles
Associate Geologist	Allan G. Barrows	Los Angeles
Associate Geologist	David J. Beeby	Los Angeles
Associate Geologist	Robert L. Hill	Los Angeles
Associate Geologist	James E. Kahle	Los Angeles
Associate Geologist	Edmund W. Kiessling	Los Angeles
Associate Geologist	Roger C. Martin	Los Angeles
Associate Geologist	Russell V. Miller	Los Angeles
Associate Geologist	Richard B. Saul	Los Angeles
Associate Geologist	Siang S. Tan	Los Angeles
Associate Geologist	John L. Burnett	Sacramento
Associate Geologist	John S. Rapp	Sacramento
Associate Geologist	Charles F. Armstrong	San Francisco[2]
Associate Geologist	Michael E. Huffman	San Francisco[2]
Associate Geologist	Frederic R. Kelley	San Francisco
Associate Geologist	Salem J. Rice	San Francisco
Associate Geologist	Trinda B. Ristau	San Francisco
Associate Geologist	Melvin C. Stinson	San Francisco
Associate Geologist	David L. Wagner	San Francisco
Associate Geochemist, Geochemical Manager	Hasmukhrai H. Majmundar	San Francisco
Associate Geochemist	Glenn A. Borchardt	San Francisco
Associate Geophysicist	John H. Bennett	Sacramento
Associate Geophysicist	Gordon W. Chase	Sacramento
Associate Seismologist	Chris H. Cramer	Sacramento
Associate Seismologist	Lalliana Mualchin	Sacramento
Associate Seismologist	Lawrence D. Porter	Sacramento
Associate Seismologist	Charles R. Real	Sacramento
Associate Seismologist	Tousson R. Toppozada	Sacramento
Assistant Geologist	William A. Bryant	Headquarters
Assistant Geologist	Marjorie M. Bushnell	Los Angeles
Assistant Geologist	David R. Fuller	Los Angeles
Assistant Geologist	Jerome A. Treiman	Los Angeles
Assistant Geologist	Quintin A. Aune	Sacramento

Classification	Employee	Location
Assistant Geologist	Stephen P. Bezore	Sacramento
Assistant Geologist	Chris T. Higgins	Sacramento
Assistant Geologist	Eddie Leivas	Sacramento
Assistant Geologist	Ralph C. Loyd	Sacramento
Assistant Geologist	Gary C. Taylor	Sacramento
Assistant Geologist	Edward J. Bortugno	San Francisco
Assistant Geologist	Richard T. Kilbourne	San Francisco
Assistant Geologist	Michael W. Manson	San Francisco
Assistant Geologist	Drew P. Smith	San Francisco
Civil Engineering Technician II	Milton J. Seaton	Sacramento
Precision Electronic Specialist	Albert G. Guyer	Sacramento
Electronics Technician	Marvin M. Huston	Sacramento
Electronics Technician	Harry P. LaGesse	Sacramento
Electronics Technician	Charles E. Luzier	Sacramento
Electronics Technician	Thomas McGrady, Jr.	Sacramento
Electronics Technician	Charles D. Turpen	Sacramento
Electronics Technician	Wayne W. Williams	Sacramento
Laboratory Technician	Charles B. Smith	San Francisco
Geologic Aid	Gordon L. Campbell	Sacramento
Geologic Aid	Ernest C. Durrwachter	Sacramento
Geologic Aid	David L. Parke	Sacramento
Geologic Aid	James G. Moreno	San Francisco
Geologic Aid	George J. Saucedo	San Francisco
Publications Supervisor	R. Merl Smith	Headquarters
Senior Geological Drafting Technician	Richard R. Moar	San Francisco
Geological Drafting Technician	Dorothy Y. Fong	Headquarters
Geological Drafting Technician	Edward L. Foster	Headquarters
Geological Drafting Technician	Jeffrey O. Tambert	Headquarters
Geological Drafting Technician	Elizabeth M. Lindgren	Los Angeles
Geological Drafting Technician	Richard T. Boylan	Sacramento
Geological Drafting Technician	Donald R. Anderson	San Francisco
Geological Drafting Technician	Robert A. Switzer	San Francisco
Graphic Artist	Ronald L. Morgan	Headquarters
Drafting Aid II	Rodney K. Wong	Headquarters
Drafting Aid II	Victor A. Protasov	Los Angeles
Librarian	Angela Brunton	San Francisco
Library Technical Assistant	Marianne Leach	San Francisco
Secretary I	Mary L. Burgess	Headquarters
Senior Stenographer	Judith Daniels	Headquarters
Senior Stenographer	Yukie Ota	Sacramento
Senior Stenographer	Josephine M. Territo	San Francisco
Editorial Aid	Mindy Lackey	Headquarters
Editorial Aid	Margaret W. Turner	Headquarters
Management Services Technician	Beverly M. Rhodes	Headquarters
Office Technician (General)	Eleanor M. Learned	San Francisco
Office Technician (Type)	Wilma B. Ashby	Los Angeles
Stenographer	Jean E. Holmes	Sacramento
Stenographer	Miriam E. Moreland	Sacramento
Stenographer	Delores Patterson	San Francisco
Stenographer	Betty E. Van Den Berg	San Francisco
Senior Account Clerk	Venice Huffman	Los Angeles

Classificiation	Employee	Location
Office Assistant II (Type)	E. Molly Goldberg	Headquarters
Office Assistant II (Type)	Claudia L. Hallstrom	Headquarters
Office Assistant II (Type)	Judith A. Klisch	Headquarters
Office Assistant II (Type)	Danielle P. Riordan	Headquarters
Office Assistant II (Type)	Brenda A. Ryder	Los Angeles
Office Assistant II (Type)	Sue Torres	Los Angeles
Office Assistant II (Type)	Vernettia G. Syphax	Sacramento
Office Assistant II (Type)	Dorothy L. Hamilton	San Francisco
Office Assistant II (Type)	Marianne K. Roja	San Francisco
Office Assistant I (Type)	David A. Thomas	Sacramento
Janitor	Andrew C. Love	San Francisco

[1] Assigned to Division from the Department of Conservation.
[2] Special assignment to the Department of Forestry.

Hired

Stephen P. Bezore	Assistant Geologist
William A. Bryant	Assistant Geologist
Marjorie M. Bushnell	Assistant Geologist
Judith Daniels	Senior Stenographer
James F. Davis	State Geologist
David R. Fuller	Assistant Geologist
E. Molly Goldberg	Office Assistant II (typing)
Claudia L. Hallstrom	Office Assistant II (typing)
Chris T. Higgins	Assistant Geologist
Judith Ann Klisch	Office Assistant II (typing)
Zoe K. Mankoski	Associate Governmental Program Analyst
Miriam E. Moreland	Stenographer
James G. Moreno	Geologic Aid
Jackie M. Nunes	Office Assistant II (typing)
Yukie Ota	Senior Stenographer
David L. Parke	Geologic Aid
Helen V. Priebe	Stenographer
John T. Ragsdale	Senior Structural Engineer
Danielle P. Riordan	Office Assistant II (typing)
Brenda A. Ryder	Office Assistant II (typing)
Vernettia G. Syphax	Office Assistant II (typing)
David A. Thomas	Office Assistant II (typing)
Jerome A. Treiman	Assistant Geologist
Charles D. Turpen	Electronics Technician
Lois F. Vial	Senior Stenographer
Wayne W. Williams	Electronics Technician

Promoted

David J. Beeby	Associate Geologist
Carl J. Hauge	Senior Geologist
Beverly M. Rhodes	Management Services Technician
Trinda B. Ristau	Associate Geologist
David L. Wagner	Associate Geologist

Transferred

John T. Alfors	Supervising Geologist
Perry Y. Amimoto	Supervising Geologist
Richard T. Boylan	Geological Drafting Technician
Ralph C. Loyd	Assistant Geologist
Drew P. Smith	Assistant Geologist

Separated

Beryl Adrian	Senior Account Clerk
Suzanne L. Cross	Senior Stenographer
Ricardo DeRama	Laboratory Technician
Donald F. Fife	Associate Geologist
Vicki L. Forrester	Office Assistant II (typing)
Bonnie Lee	Stenographer
William Y. Lo	Geologic Aid
Marcos R. Loza	Laboratory Technician
Jackie M. Nunes	Office Assistant II (typing)
Helen V. Priebe	Stenographer
Theodore C. Smith	Assistant Geologist
Gloria Tomei	Office Technician
Lois F. Vail	Senior Stenographer

Deceased

Yvor H. Smitter	Associate Geologist

Temporary Staff

Lydia Lofgren	Laboratory Technician
Coleen F. Davis	Office Assistant II (typing)
Vicki L. Forrester	Office Assistant II (typing)
Shirley A. Rowley	Office Assistant II (typing)
Maria Salinas	Seasonal Clerk
Ruth Yue	Seasonal Clerk
Paul Buckholz	Graduate Student Assistant
Gregory L. Chargin	Graduate Student Assistant
Phillip A. Levine	Graduate Student Assistant
David L. Parke	Graduate Student Assistant
David R. Smith	Graduate Student Assistant
Bill N. Wong	Graduate Student Assistant
Jerry Braithwaite	Student Assistant
Norman Braithwaite	Student Assistant
Connie Celum	Student Assistant
K. Douglas Cook, Jr.	Student Assistant
Jeffrey F. Eppink	Student Assistant
Bruce Hitchman	Student Assistant
Suzanne D. Huntley	Student Assistant
John H. Luksch	Student Assistant
Matthew S. Mahronich Jr.	Student Assistant
Katherine McDowell	Student Assistant
Debra Nishida	Student Assistant

Temporary Staff (continued)

Marla Partin	Student Assistant
Daniel Sabatino	Student Assistant
Woody Sutherland	Student Assistant
Lisa Yue	Student Assistant
Stephen G. Belluomini	Volunteer
Gary Bates	Volunteer
Gail Donoghue	Volunteer
Jennifer S. East	Volunteer
John N. Harrington	Volunteer
Diane Heath	Volunteer
David Thormahlen	Volunteer
William O. Ward	Volunteer

III. Interagency Activities

In carrying out its program, the Division participated in a number of interagency activities. Some of the interagency groups in which the Division was involved during the fiscal year are:

- Advisory Board to Strong Motion Instrumentation Program
- Advisory Committee on Geographic Names
- Building Safety Board (Department of Health) - Geotechnical Subcommittee
- California Coastal Commission
- California Energy Resources Conservation and Development Commission
- Geothermal Resources Board
- Monterey Basin Pilot Monitoring Project Committee
- Nuclear Regulatory Commission
- Office of Emergency Services, Earthquake Prediction Evaluation Council
- Public Utilities Commission
- Resources Agency Task Force on Timber Harvest Plan Review
- Seismic Safety Commission - Hospital Act Committee
- State Solid Waste Management Board
- State Solid Waste Management and Resources Recovery Advisory Council
- Technical Advisory Committee to Geothermal Resources Board
- Technical Advisory Committee to San Francisco Bay Conservation and Development Commission

IV. Budget Summary

Expenditures by Program Component

Geologic Hazards and Mineral Resources Conservation Program

	Personnel Years	Dollars	Personnel Years	Dollars
Land Use Geology and Seismicity Element			71.8	$2,606,597
Basic Investigations Component	7.4	$ 268,472		
Hazards Reduction Component	64.4	2,338,125		
Mineral Resources Conservation Element			12.6	458,048
Deposit Inventory Component	7	255,298		
Land Classification Component	4.6	167,889		
Mined Land Reclamation Component	1	34,861		
Geologic Information and Publication Element			22.7	707,976
Information Component	10.9	192,685		
Publications Component	11.8	515,291		
Administration Element			29.6	909,067
TOTAL EXPENDITURES			136.7	$4,681,688

Source of Funds

General Fund	$3,328,955
State Highway Account, State Transportation Fund	11,400
California Water Fund	11,400
Strong-Motion Instrumentation Program Fund	667,450
Federal Funds	134,475
Reimbursements	528,008
TOTAL	$4,681,688

V. State Mining and Geology Board

The State Mining and Geology Board is a nine-member board. Each member is appointed by the Governor to serve a four-year term. The Governor designates the chairman, who shall hold such office at the Governor's pleasure. The vice-chairman is elected annually. The Board began the fiscal year with eight members. Two members, Douglas W. Sprague and Eleanor J. Young, resigned during the fiscal year; and two new members, James A. Anderson and Raymond E. Krauss, were appointed on April 25, 1978. At the end of the fiscal year one vacancy still remained.

The Board's responsibilities, as stated in Sections 672-677 of the Public Resources Code, are as follows:

"The Board shall represent the state's interest in the development, utilization, and conservation of the mineral resources of the state and the reclamation of mined lands, as provided by law, and federal matters pertaining to mining, and shall determine, establish, and maintain an adequate surface mining and reclamation policy. The Board shall also represent the state's interest in the development of geological information necessary to the understanding and utilization of the state's terrain, and information pertaining to earthquake and other geologic hazards. General policies for the Division shall be determined by the Board.

"The Board shall also serve as a policy and appeals board for the purposes of the Alquist-Priolo Special Studies Zones Act (Chapter 7.5, Division 2, Public Resources Code).

"On or before December 31 of each year, the Board shall submit to the Governor and the Legislature recommendations regarding needed research projects relating to the state's terrain, mineral resources, mining, the reclamation of mined lands, and earthquakes and other geologic hazards.

"The Board may provide for a statewide program of research regarding the technical phases of reclaiming mined lands which may be delegated to it by law and may accept funds from the United States or from any person to aid in carrying out the provisions of this section. The Board may conduct such a program independently or by contract or in cooperation with any person, public or private organization, federal agency, or state agency, including any political subdivision of the state.

"The Board shall provide for a public information program on matters involving the state's terrain, mineral resources, mining, the reclamation of mined lands, and earthquakes and other geologic hazards."

The State Geologist, who serves as Chief of the Division, is appointed under provision of the State Civil Service Act by the Director of the Department of Conservation upon nomination by the Board.

During the fiscal year 1977-78 the Board met as follows:

July 29	Sacramento	Feb. 17	San Francisco
Aug. 19	San Francisco	April 22	Monterey
Oct. 15	Stockton	May 26	Redding
Nov. 18	Sacramento	June 30	Sacramento
Jan. 13	Sacramento		

1. Major board actions, fiscal year 1977-78

At the November 18, 1977 meeting in Sacramento, the Board received a mineral lands classification study of the Stanislaus River area prepared by the Division of Mines and Geology. The study was requested by the Board as a test case for its recently adopted Guidelines for Classification of Mineral Lands.

Field trips were taken by the board to inspect sand and gravel mining operations and reclamation practices in San Diego County and in the Central Valley area along the Stanislaus River. The Board also looked at instream aggregate extraction operations along the Russian River and Kelsey Creek in the Santa Rosa area.

The 1977 Annual Report to the Governor and the Legislature was submitted by the Board on January 13, 1978.

In conjunction with the April 22, 1978 Board meeting in Monterey, the Board visited mining operations in Monterey, San Benito, and Santa Cruz Counties to inspect the effect of its Surface Mining and Reclamation Guidelines on actual reclamation practice.

The Mining and Geology Board adopted Guidelines for Classification and Designation of Mineral Lands after a public hearing held in Sacramento on June 30, 1978.

The Board nominated James F. Davis to the position of State Geologist.

2. Membership: State Mining and Geology Board

BOARD MEMBER	CURRENT TERM (Expires January 15)	FIRST APPOINTED	SPECIALTY (per Sec. 662, PRC)
ROBERT H. TWISS (CHAIRMAN) 410 Yale Street Kensington, CA 94708	1976-1978	1976	Landscape architect: soil conservation or revegetation (Univ. of Calif. Coll. of Environmental Design Dept. of Landscape Architecture)

BOARD MEMBER	CURRENT TERM (Expires January 15)	FIRST APPOINTED	SPECIALTY (per Sec. 662, PRC)
JAMES A. ANDERSON Vice President Homestake Mining Company 650 California Street San Francisco, CA 94108	1976-1981	1978	Registered geologist: mining geology (Homestake Mining Co.)
ALCIDES S. FREITAS 5510 Linda Lane Carmichael, CA 95806	1978-1981	1976	Environmental protection (Sacramento County Office of Environmental Management)
WILLARD P. FULLER, JR. P.O. Box 745 San Andreas, CA 95249	1978-1981	1976	Mining engineer: mining minerals in California (Calaveras Cement Co.)
ARTHUR GRANTZ (VICE CHAIRMAN) 380 Olive Street Menlo Park, CA 94025	1976-1979	1976	Mineral resource (U.S. Geological Survey)
RAYMOND E. KRAUSS 6969 St. Helena Road Santa Rosa, CA 95404	1978-1979	1978	Local government representative (Sonoma County Planning Department)
RETURN F. MOORE President, Moore & Taber 4530 East La Palma Avenue Anaheim, CA 92807	1976-1980	1976	Registered civil engineer: soil engineering (Moore & Taber)
TA-LIANG TENG Professor of Geophysics Department of Geological Sciences University of Southern California University Park Los Angeles, CA 90007	1976-1980	1976	Registered geophysicist: seismology (USC)
VACANCY			Non-specialized experience

VI. Statutory Authority

The Division operates under the authorities set forth in Chapter 2 of Division 1 and Chapters 1 and 2 of Division 2 of the Public Resources Code. The significant sections are summarized here:

Sections	Substance of Law
601, 607	Establishes Department of Conservation in The Resources Agency and Division of Mines and Geology and three other Divisions in Department of Conservation.
660-667	Establishes State Mining and Geology Board and its responsibilities.
680	Establishes State Geologist as Chief of Division.
2201	State Geologist shall employ geologists and qualified specialists to do Division's work.
2203	State Geologist shall submit an annual report, including review of measures taken to counter geologic hazards, and review of economic utilization and conservation of State's mineral resources.
2204	State Geologist may receive and manage gifts on behalf of State.
2205	State Geologist may: Study mineral resources, mineral industries, and geology of the state; Collect mineral statistics; Collect geological and mineralogical specimens and models to constitute Division's exhibits; Provide technical library to be Division's library; Maintain, in effect, a bureau of information on the State's mineral industries; Conduct studies of geologic hazards in urban areas, including activities under cooperative agreements; Maintain a laboratory to perform physical and chemical tests and analyses; Issue reports and maps on the geology of the State and the statistics and technology of the State's mineral industries.
2207	State Geologist shall compile and publish statistical bulletins to show totals of minerals produced, annually.
2622	State Geologist shall delineate Special Studies Zones to encompass potentially and recently active faults (Alquist-Priolo Act).
2650	State Geologist shall carry out State Mining and Minerals Policy.
2700	State Geologist shall conduct the Strong-Motion Instrumentation Program throughout the State.
2710-2793	Establishes the Surface Mining and Reclamation Act of 1975 to regulate surface mining operations.

VII. Recent Legislation

During 1977-78 the following measures of concern to the Division of Mines and Geology were enacted into law:

Assembly Joint Resolution 29, Keysor Chapter 32	Memorializes Congress to enact pending Federal legislation creating National Earthquake Hazards Program. Chaptered June 21, 1977.
Assembly Joint Resolution 14, Lehman and others Chapter 31	Memorializes President and Congress to continue funding for Auburn dam, depending on determination of its seismic safety. Chaptered June 17, 1977.
SB115, Nejedly Chapter 963	Provides for compensating State Mining and Geology Board members $100 per day spent on actual duty, in addition to expenses, and appropriates $10,000 to cover costs. Approved by the Governor September 21, 1977; effective January 1, 1978.
SB1279, Alquist Chapter 154	Authorizes Seismic Safety Commission to undertake two-year study to determine the feasibility of the State's creating and maintaining an earthquake prediction and hazard reduction system; provides for total of $350,000 for study. Approved by the Governor May 24, 1978; effective May 24, 1978 (urgency bill).

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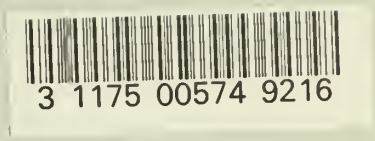
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